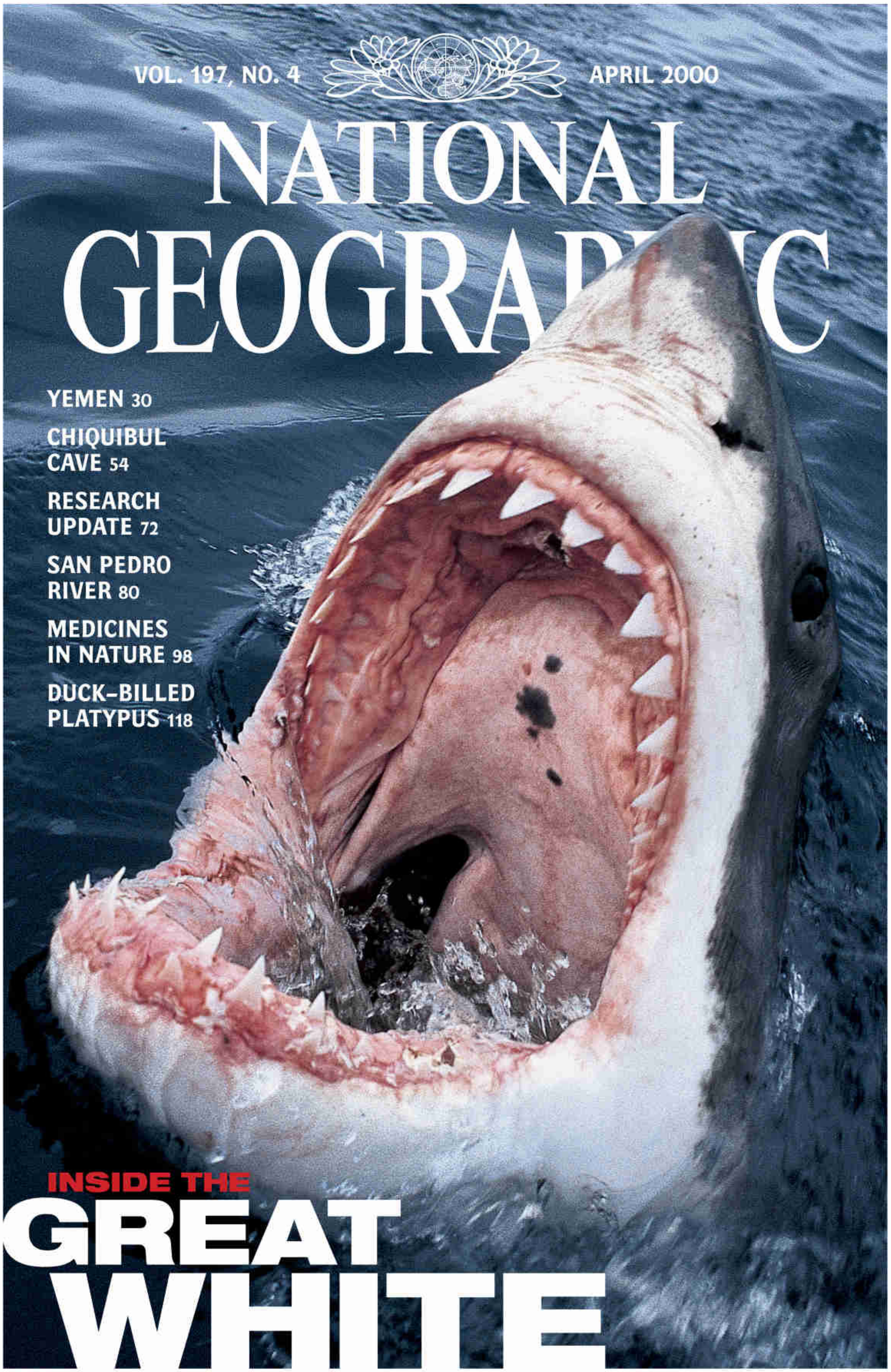
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INSIDE THE

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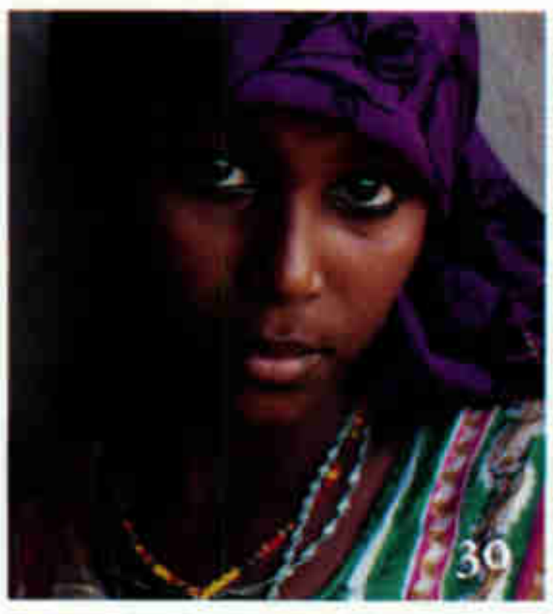
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NATIONAL GEOGRAPHIC

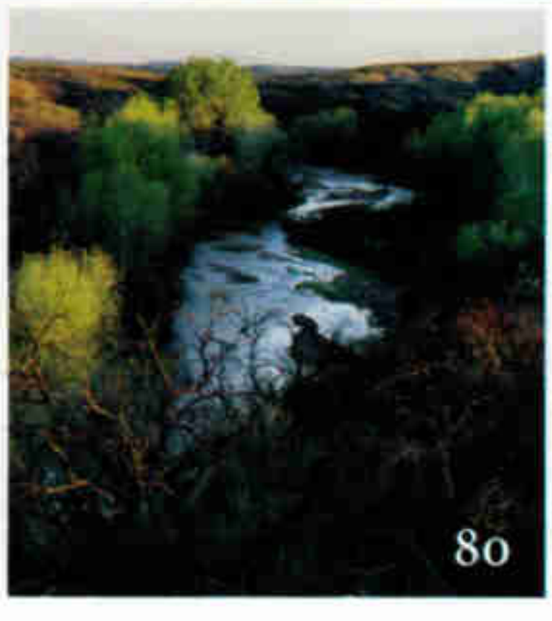
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98 **Nature's Rx** *Where Western medicine hasn't been an option —and today even where it is—millions turn to traditional therapies to cure their ills. Do natural remedies really work, and can science unlock their secrets?*
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The Cover

Infamous jaws of a great white shark off the coast of South Africa belie the fragility of the species, threatened by nets, long-lines, and illegal fishing. Photograph by David Doubilet

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NATIONAL GEOGRAPHIC

On Assignment

■ YEMEN

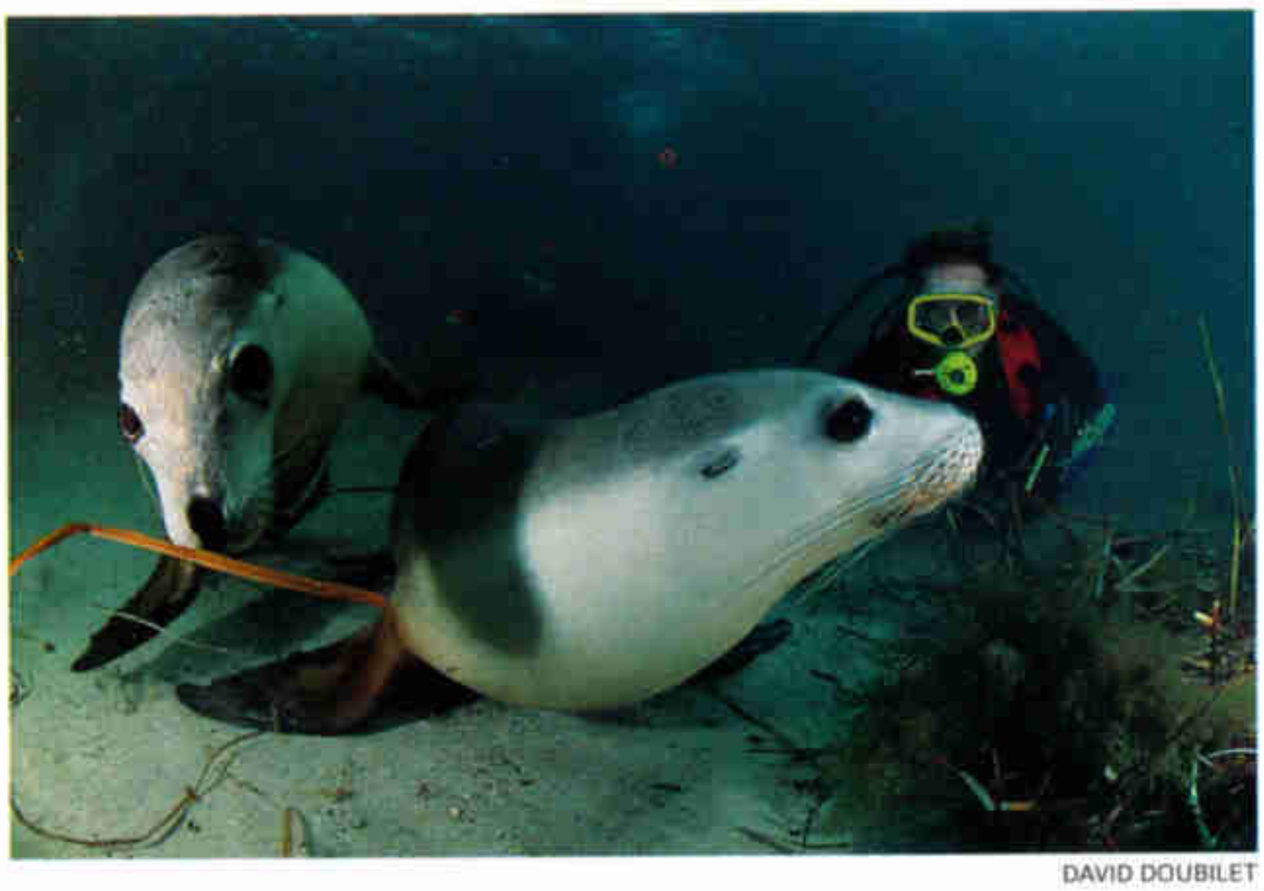
Keep It Short and Simple

"I don't think his eyesight was very good, but I figured my hair was so sparse it didn't matter," says photographer Steve McCurry. After lugging his cameras around the spice market in Taizz all day, Steve wanted to rest somewhere. When he saw a barbershop, he sat down in the empty chair—the only seat in the shop.

It cost Steve just a quarter for the trim. "The barber was very serious about his work," says Steve, "but his scissors were so dull, I don't know how much hair he really cut."



STEVE McCURRY



DAVID DOUBILET

■ GREAT WHITE SHARKS

Catch of the Day

"Swimming with sea lions in South Australia, I had the creepy sensation that I was an anchovy in a gigantic smorgasbord," says Peter Benchley, who spent a lot of time underwater while working on the great white shark story.

He visited this same sea lion colony near the Neptune Islands 25 years ago, after *Jaws* was published. Since then the author has become an active environmentalist, arguing that humans are the real threat—it's the sharks that need protection.

■ MEDICINES IN NATURE

The Roots of Healing

"It looked like the witches' brew in *Macbeth,*" says Joel Swerdlow of this pharmaceutical factory in Kerala, India, that makes medicines from natural ingredients. "There were huge fermentation vats with big sticks for stirring the mixture of roots and leaves." Outside the factory Joel stands by piles of roots used in herbal medicines. He became convinced of the benefits of botanical medicine after years of study and some personal experiences. While in India, "a whole body massage using Ayurvedic herbs left me feeling fantastic."



LYNN JOHNSON

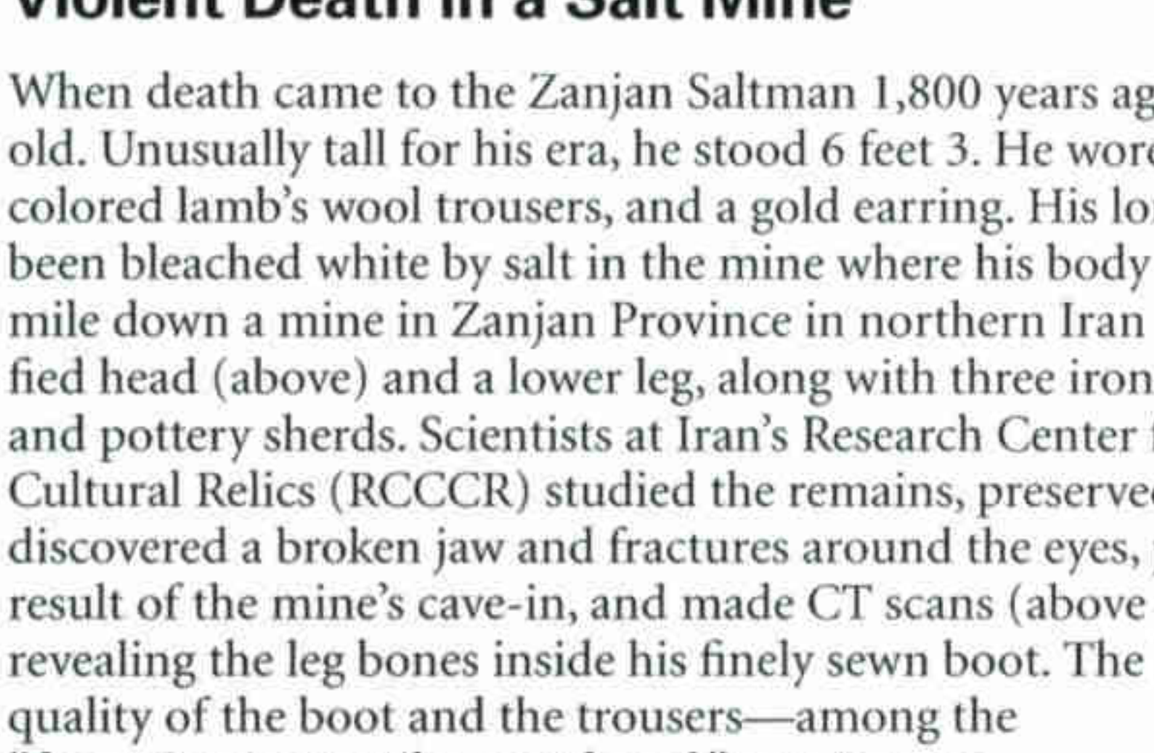
NATIONAL GEOGRAPHIC
Geographica



MICHAEL YAMASHITA (ABOVE AND RIGHT); RESEARCH CENTER FOR CONSERVATION OF CULTURAL RELICS

Violent Death in a Salt Mine

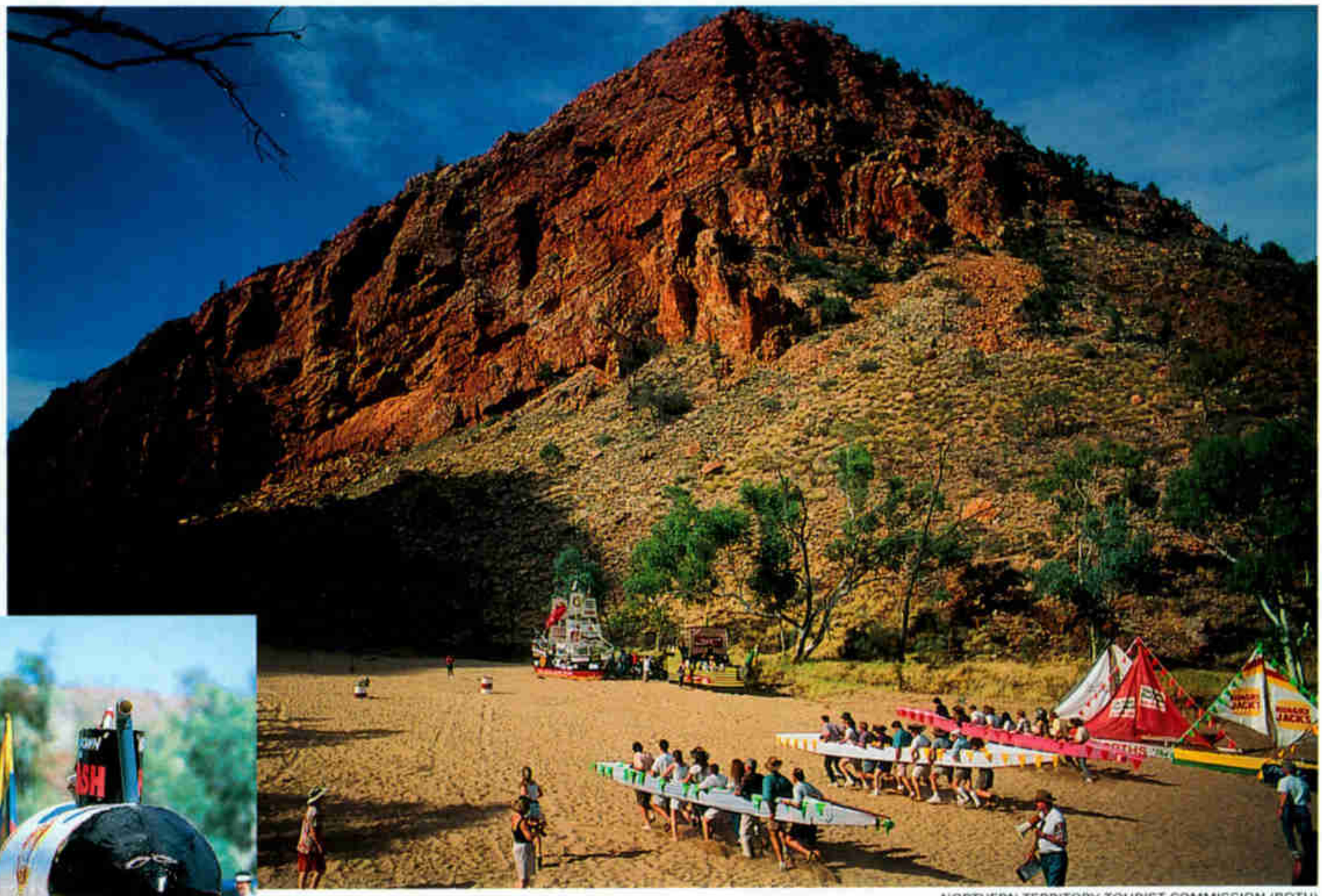
When death came to the Zanjan Saltman 1,800 years ago, he was about 40 years old. Unusually tall for his era, he stood 6 feet 3. He wore leather boots, cream-colored lamb's wool trousers, and a gold earring. His long hair and beard had been bleached white by salt in the mine where his body lay. Workers half a mile down a mine in Zanjan Province in northern Iran found his mummified head (above) and a lower leg, along with three iron knives, a sling stone, and pottery sherds. Scientists at Iran's Research Center for Conservation of Cultural Relics (RCCCR) studied the remains, preserved by the salt. They discovered a broken jaw and fractures around the eyes, perhaps the result of the mine's cave-in, and made CT scans (above right) revealing the leg bones inside his finely sewn boot. The high quality of the boot and the trousers—among the "finest Persian textiles ever found," says Pouran Eslami, an anthropologist at Riverside Community College in California—led Abdolrasool Vatandoust, RCCCR's director, to speculate that the man may have been a prince.



VINCENT J. MUSI

New Kicks for Route 66?

The 2,448-mile-long "mother road" from Chicago to southern California (GEOGRAPHIC, September 1997) may yet live on. A new law authorizes the Interior Department to spend ten million dollars over the next decade to support state and local efforts to preserve what's left of U.S. Route 66 and highlight its historical importance. "Unlike today's interstate highways, Route 66 is a bona fide destination in itself," says New Mexico Congresswoman Heather Wilson, one of the sponsors of the enabling legislation.





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Run, Run, Run Your Boat. . . .

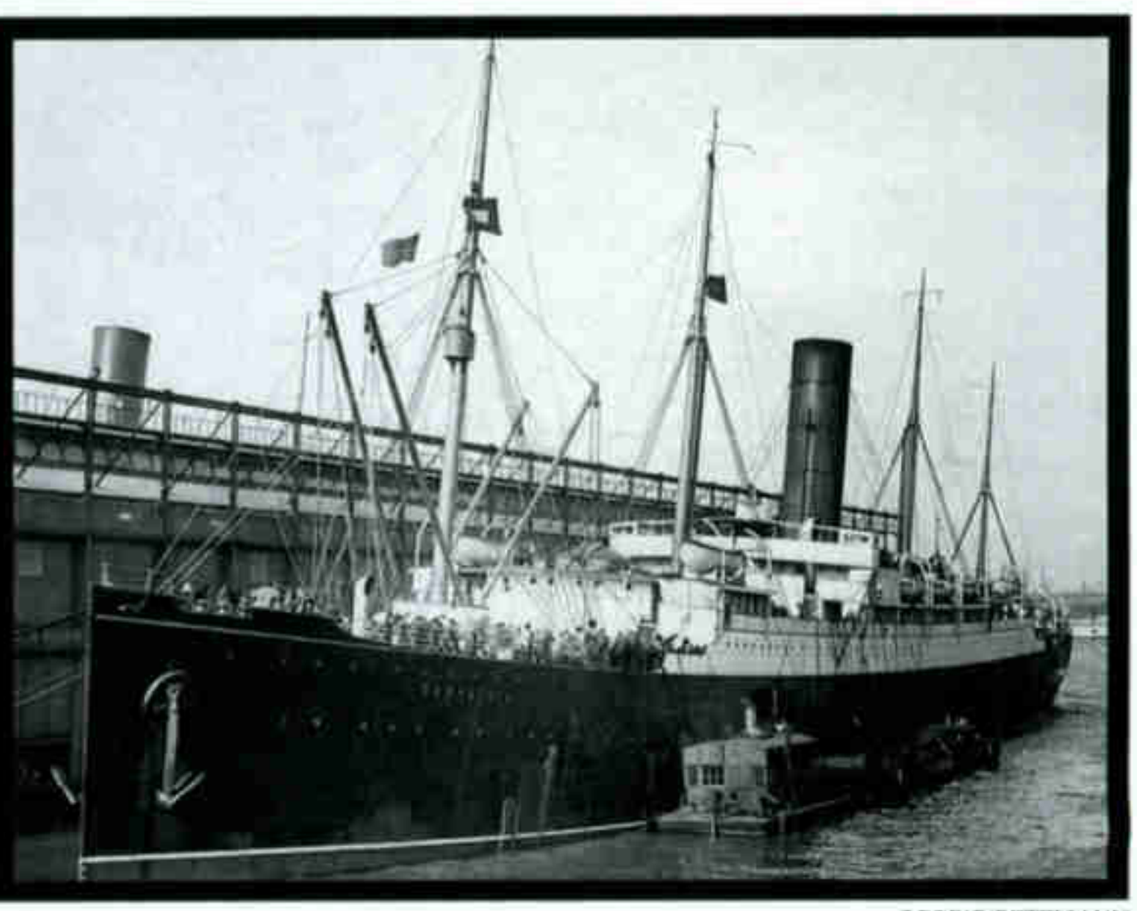
Alice Springs sits smack in the heart of the Australian desert, a thousand miles from the nearest major body of water. What better place, then, to hold a regatta?

With a typically Australian sense of the absurd, the outback city hosts the Henley-on-Todd Regatta each October, a gentle spoof of the serious rowing that marks England's annual Henley on Thames competition. Since the Todd River, which (sort of) runs through Alice Springs, is almost always dry, contestants must make their way up and down the riverbed, their legs sticking out through specially designed bottomless craft. Races have involved eights, fours, kayaks, an armada of other offbeat boats like this sub (above left), and the ever popular four-men-carrying-a-woman-in-a-bathtub.

Henley-on-Todd has been canceled only once since it began in 1962: Rain had fallen, the Todd flooded, and the regatta was halted because of water.

Locating a Heroic Vessel

In the *Titanic* saga, *Carpathia* played a valiant role, rescuing 706 survivors and delivering them to New York in April 1912 (right). Six years later she herself sank—torpedoed by a German U-boat in World War I. Now marine salvager Graham Jessop believes he has found her wreckage 185 miles west of England's southwestern tip. Side-scan sonar images show her 600 feet down, upright and intact on the flat, sandy bottom. Jessop plans to film the wreck using a remotely operated vehicle.



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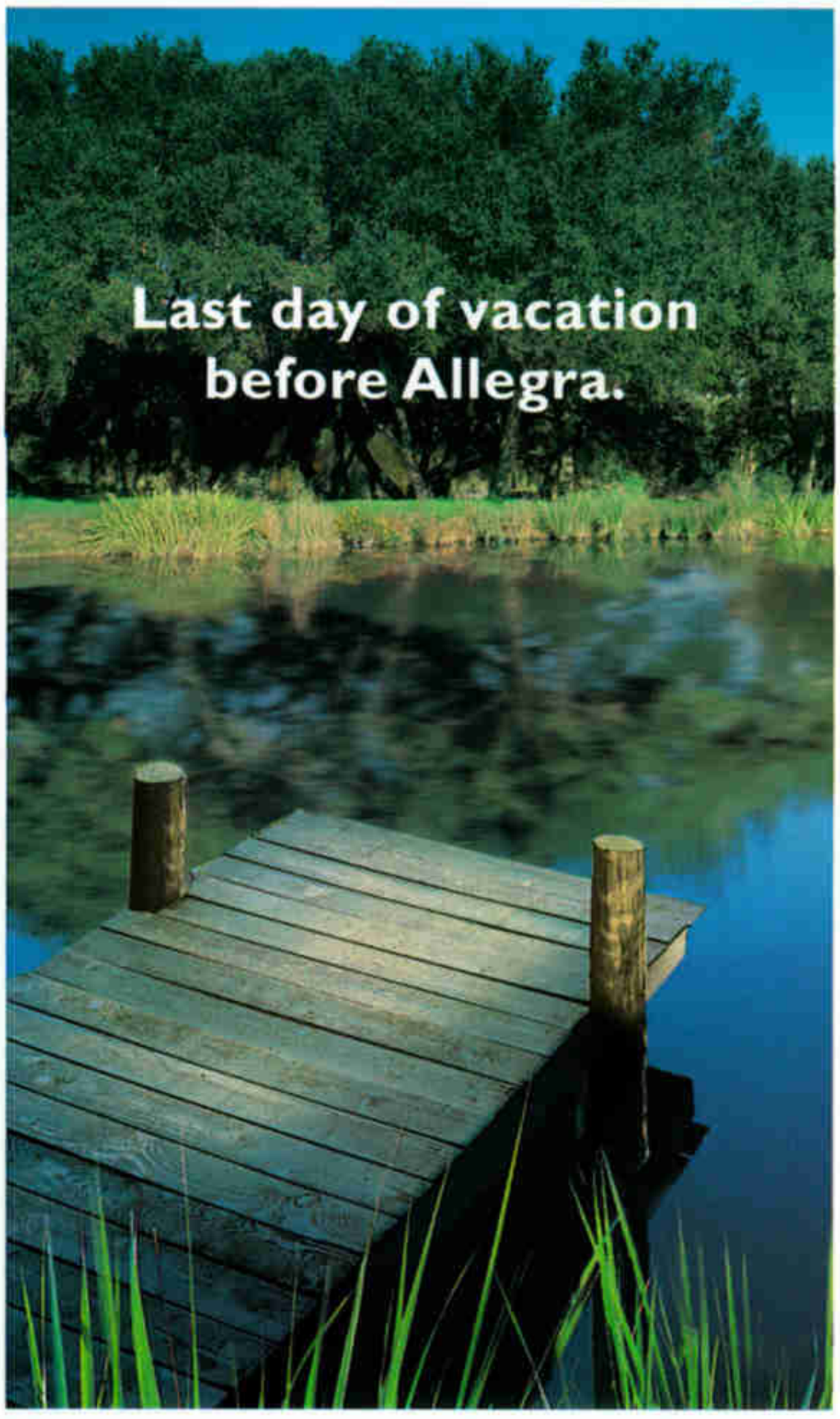


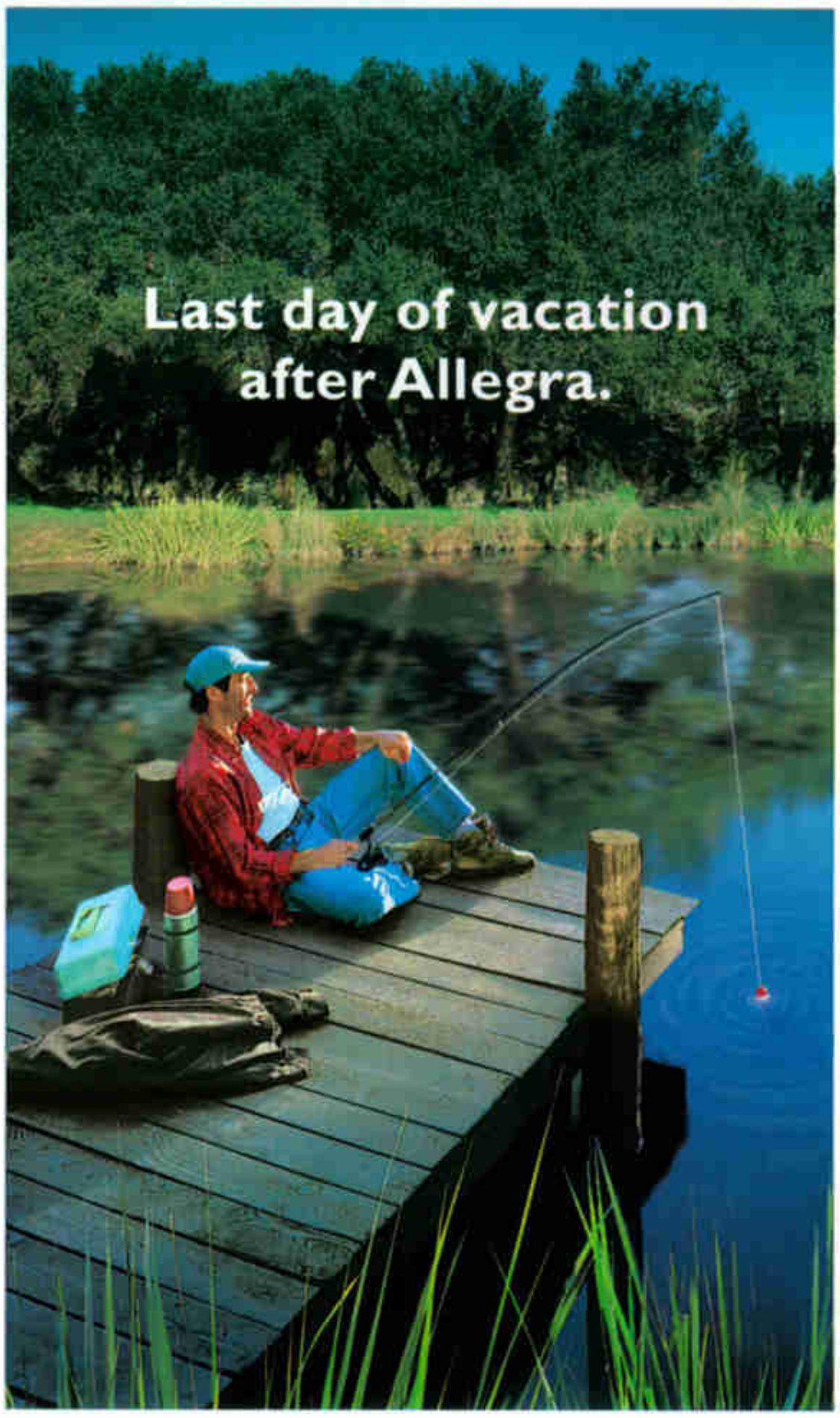
■ NGS EXPEDITIONS COUNCIL GRANT

The Grand Canyon's Hidden Art Galleries

Parading silently across a rock-shelter wall 1,500 feet deep in the western Grand Canyon, these animals show that prehistoric people penetrated the highly inaccessible region. In the fall of 1998 explorer Scott Thybony led an expedition that photographed this canyon art gallery and discovered several others that feature distinctive works depicting spectral human forms, geometric shapes, and numerous animals. Some were incised into rock, but most were painted on walls or ceilings with ground mineral pigments. Thybony and river guide Mary Allen, a rock art researcher, found a grinding tool suitable for making paint. Some pigments may have been mixed with organic binders such as plant juice or urine that could serve to date the works.

SCOTT THYBONY





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Brief Summary of Prescribing Information as of June 1998A

ALLEGRA®
(fexofenadine hydrochloride) Capsules
60 mg

INDICATIONS AND USAGE

ALLEGRA is indicated for the relief of symptoms associated with seasonal allergic rhinitis in adults and children 12 years of age and older. Symptoms treated effectively include sneezing, rhinorrhea, itchy nose/palate/throat, itchy/watery/red eyes.

CONTRAINDICATIONS

ALLEGRA is contraindicated in patients with known hypersensitivity to any of its ingredients.

PRECAUTIONS

Drug Interactions

Fexofenadine has been shown to exhibit minimal (ca. 5%) metabolism. However, co-administration of fexofenadine with ketoconazole and erythromycin led to increased plasma levels of fexofenadine. Fexofenadine had no effect on the pharmacokinetics of erythromycin and ketoconazole. In two separate studies, fexofenadine HCl 120 mg BID (twice the recommended dose) was co-administered with erythromycin 500 mg every 8 hours or ketoconazole 400 mg once daily under steady-state conditions to normal, healthy volunteers (n=24, each study). No differences in adverse events or QTc interval were observed when subjects were administered fexofenadine HCl alone or in combination with erythromycin or ketoconazole. The findings of these studies are summarized in the following table:

Effects on Steady-State Fexofenadine Pharmacokinetics After 7 Days of Co-Administration with Fexofenadine Hydrochloride 120 mg Every 12 Hours (twice recommended dose) in Normal Volunteers (n=24)

Concomitant Drug	$C_{max\,SS}$ *(Peak plasma concentration)*	$AUC_{SS}(0\text{-}12h)$ *(Extent of systemic exposure)*
Erythromycin (500 mg every 8 hrs)	+82%	+109%
Ketoconazole (400 mg once daily)	+135%	+164%

The changes in plasma levels were within the range of plasma levels achieved in adequate and well-controlled clinical trials. The mechanism of these interactions has been evaluated in *in vitro*, *in situ* and *in vivo* animal models. These studies indicate that ketoconazole or erythromycin co-administration enhances fexofenadine gastrointestinal absorption. In vivo animal studies also suggest that in addition to enhancing absorption, ketoconazole decreases fexofenadine gastrointestinal secretion, while erythromycin may also decrease biliary excretion.

Carcinogenesis, Mutagenesis, Impairment of Fertility

The carcinogenic potential and reproductive toxicity of fexofenadine hydrochloride were assessed using terfenadine studies with adequate fexofenadine exposure (based on plasma area-under-the-curve [AUC] values). No evidence of carcinogenicity was observed when mice and rats were given daily oral doses of 50 and 150 mg/kg of terfenadine for 18 and 24 months, respectively; these doses resulted in plasma AUC values of fexofenadine that were up to four times the human therapeutic value (based on a 60-mg twice-daily fexofenadine hydrochloride dose).

In in-vitro (Bacterial Reverse Mutation, CHO/HGPRT Forward Mutation, and Rat Lymphocyte Chromosomal Aberration assays) and in-vivo (Mouse Bone Marrow Micronucleus assay) tests, fexofenadine hydrochloride revealed no evidence of mutagenicity.

In rat fertility studies, dose-related reductions in implants and increases in postimplantation losses were observed at oral doses equal to or greater than 150 mg/kg of terfenadine; these doses produced plasma AUC values of fexofenadine that were equal to or greater than three times the human therapeutic value (based on a 60-mg twice-daily fexofenadine hydrochloride dose).

Pregnancy

Teratogenic Effects: Category C. There was no evidence of teratogenicity in rats or rabbits at oral terfenadine doses up to 300 mg/kg; these doses produced fexofenadine plasma AUC values that were up to 4 and 37 times the human therapeutic value (based on a 60-mg twice-daily fexofenadine hydrochloride dose), respectively.

There are no adequate and well-controlled studies in pregnant women. Fexofenadine hydrochloride should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

Nonteratogenic Effects. Dose-related decreases in pup weight gain and survival were observed in rats exposed to oral doses equal to and greater than 150 mg/kg of terfenadine; at these doses the plasma AUC values of fexofenadine were equal to or greater than 3 times the human therapeutic values (based on a 60-mg twice-daily fexofenadine hydrochloride dose).

Nursing Mothers

There are no adequate and well-controlled studies in women during lactation. Because many drugs are excreted in human milk, caution should be exercised when fexofenadine hydrochloride is administered to a nursing woman.

Pediatric Use

Safety and effectiveness of ALLEGRA in pediatric patients under the age of 12 years have not been established. Across well-controlled clinical trials in patients with seasonal allergic rhinitis, a total of 205 patients between the ages of 12 to 16 years received doses ranging from 20 mg to 240 mg twice daily for up to two weeks. Adverse events were similar in this group compared to patients above the age of 16 years.

Geriatric Use

In placebo-controlled trials, 42 patients, age 60 to 68 years, received doses of 20 mg to 240 mg of fexofenadine twice daily for up to two weeks. Adverse events were similar in this group to patients under age 60 years.

ADVERSE REACTIONS

In placebo-controlled clinical trials, which included 2461 patients receiving fexofenadine hydrochloride at doses of 20 mg to 240 mg twice daily, adverse events were similar in fexofenadine hydrochloride and placebo-treated patients. The incidence of adverse events, including drowsiness, was not dose related and was similar across subgroups defined by age, gender, and race. The percent of patients who withdrew prematurely because of adverse events was 2.2% with fexofenadine hydrochloride vs 3.3% with placebo. All adverse events that were reported by greater than 1% of patients who received the recommended daily dose of fexofenadine hydrochloride (60 mg twice-daily), and that were more common with fexofenadine than placebo, are listed in the following table.

Adverse Experiences Reported in Placebo-Controlled Seasonal Allergic Rhinitis Clinical Trials at Rates of Greater Than 1%

Adverse Experience	*Fexofenadine 60 mg Twice Daily (n=679)*	*Placebo Twice Daily (n=671)*
Viral Infection (cold, flu)	2.5%	1.5%
Nausea	1.6%	1.5%
Dysmenorrhea	1.5%	0.3%
Drowsiness	1.3%	0.9%
Dyspepsia	1.3%	0.6%
Fatigue	1.3%	0.9%

Adverse events occurring in greater than 1% of fexofenadine hydrochloride-treated patients (60 mg twice daily), but that were more common in the placebo-treated group, include headache and throat irritation.

The frequency and magnitude of laboratory abnormalities were similar in fexofenadine hydrochloride and placebo-treated patients.

Prescribing Information as of June 1998A

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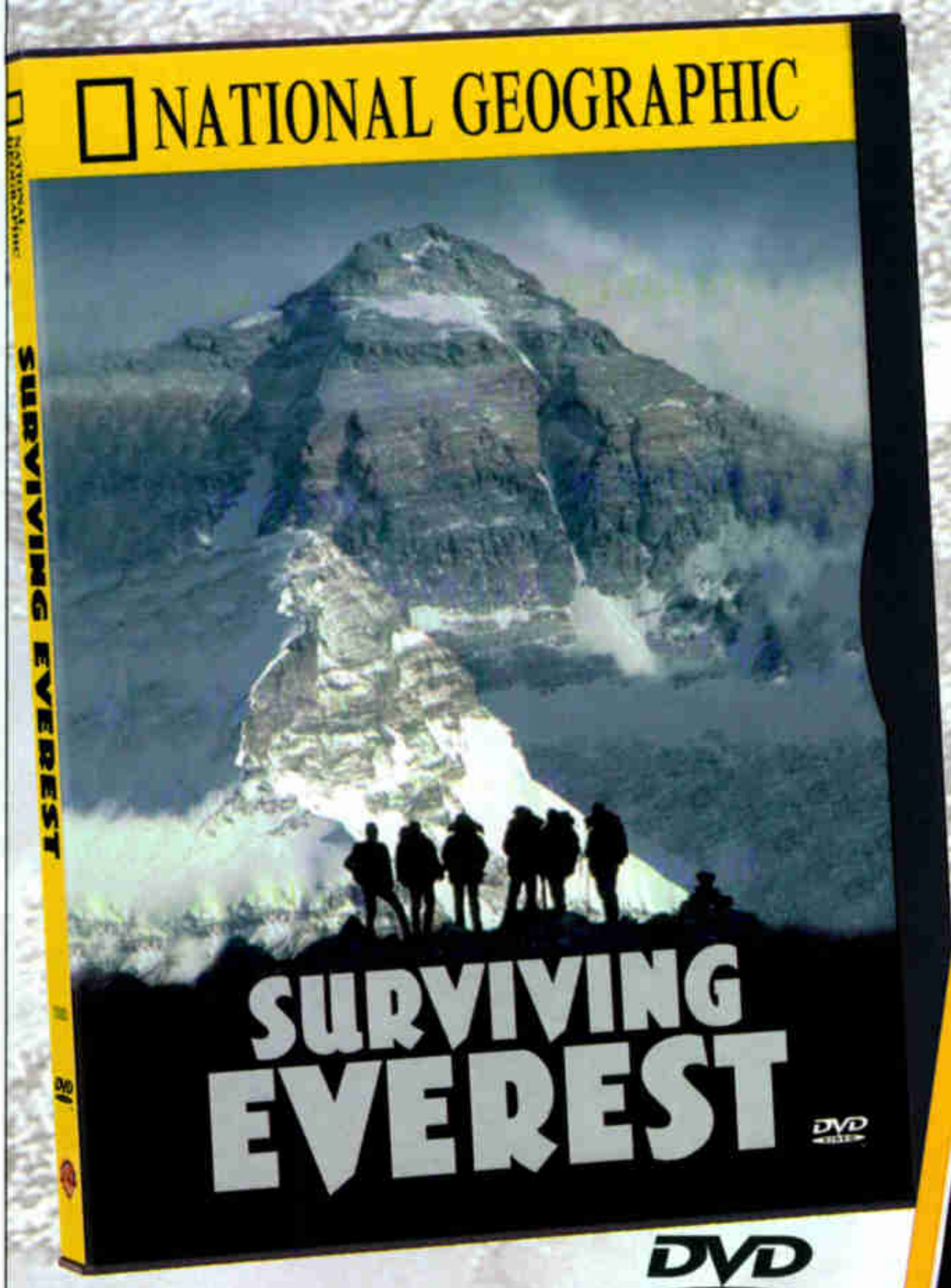
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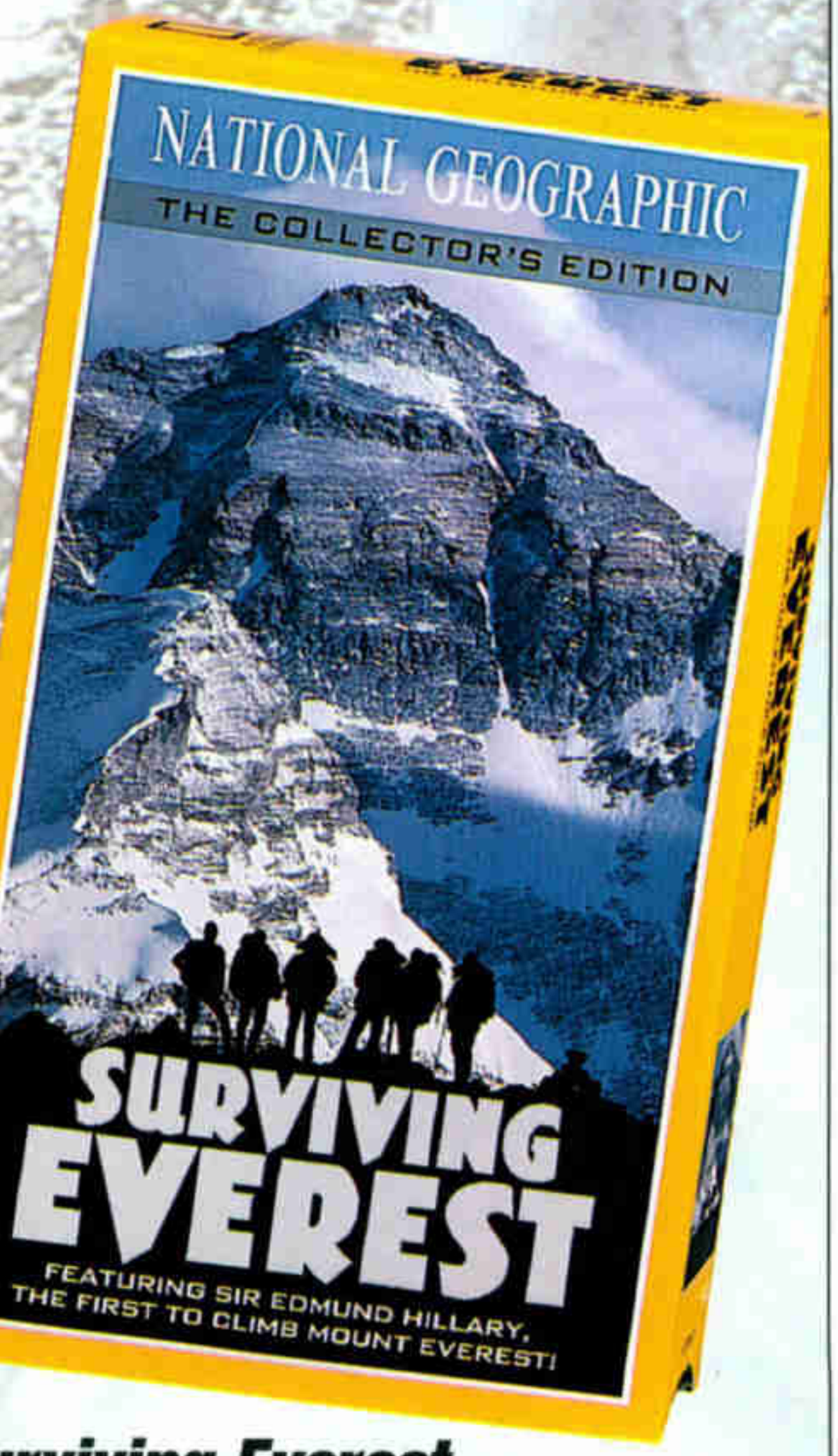
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Mementos of Scandal

A century ago Alfred Dreyfus was more than a person: As a Jewish army captain falsely accused of treason, he was the symbol of an *affaire* that wracked France's Third Republic. Now his descendants have given more than 3,000 letters, photographs, posters, and postcards—like this one written by a Dreyfus supporter (top)—to the new Museum of Jewish Art and History in Paris. "Most of the collection was held or gathered by the family," says his granddaughter, Simone Perl. "We were determined to find the right way to preserve it."



Dreyfus, the only Jew on the army's general staff, was arrested in 1894 after a document purporting to contain military secrets turned up in the German Embassy. In an atmosphere of intense anti-Semitism he was tried, convicted, publicly degraded, and exiled to Devil's Island, off South America. Supporters kept the case alive, and he won a new trial in 1899, a year after novelist Émile Zola published his famous letter accusing authorities of false testimony (above). Dreyfus was again convicted but pardoned ten days later. The army "rehabilitated" him in 1906; not until 1995 did it declare him innocent.

Stone Cold Cash

Streets on the western Pacific island of Yap are not paved with gold, but they are lined with money—almost 2,000 stone disks up to 12 feet in diameter, quarried on Palau, 320 miles away. Part of a stone's original value lay in the difficulty of its trip to Yap. Now the stones form a backdrop at rituals like this men's sitting dance. Traditionally used as gifts or payments linked to ceremonies, stones coexist with bills and coins. "I need dollars to pay my telephone bill," says John Mangefel, Yap's former governor. "But for gifts at a betrothal, dollars are useless."



DAVID WRIGHT

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"I try to know the hazards I'll encounter and plan for them. I make sure my diving gear is in top condition, and pay careful attention to the engineering details of my underwater photographic equipment. I try to prepare myself mentally and physically for the unexpected, so if it comes my way, I can cope. Sometimes, I'll even use remote camera systems to put distance between me and the hazards of the deep. Through preparation and good engineering, I minimize the dangers. And that frees me up to focus on making great pictures!" BILL CURTSINGER



PHOTO: BILL CURTSINGER

THE ROAD TO SAFETY

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5. Name one feature on the new 2000 Ford Taurus.

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Mail entries to: Ford Taurus Safety Sweepstakes, 1145 17th Street NW, Washington, DC 20036; attn: Mable Allgood.

1) NO PURCHASE NECESSARY. 2) Send a postcard to the address above with your name, address, phone number and the answers to the quiz. 3) One entry per person. 4) Entrants must be U.S. residents, 21 years of age or older. Employees of the National Geographic Society, their agents, affiliates and subsidiaries and immediate family members are not eligible. 5) Entries must be received no later than May 30, 2000. No responsibility is assumed for late, lost, misdirected or postage-due mail. All entries become the property of National Geographic and will not be returned. 6) One grand prize, 50 second place, and 25 third place winners will be selected on or about June 15, 2000 in a random drawing among all correct entries. Decisions of the judges shall be final. Odds of winning depend on number of correct entries received. Winners will be notified by phone. 7) Grand Prize winner receives a trip for two, including round-trip coach airfare from the major airport nearest winner's residence and two nights double occupancy hotel accommodations (approximate retail value: $2,500). Trip does not include meals, gratuities, taxes or any other expenses not specifically listed herein. The trip must be scheduled between September 1, 2000 and June 30, 2001; exact dates will be confirmed at least 2 months prior to departure; certain restrictions apply. If winner cannot take trip on the specified date, the prize may be forfeited and an alternative winner may be selected. 8) 50 second place winners receive an autographed copy of *National Geographic Photographs: The Milestones* ($50); 25 third place winners receive *National Geographic Photography Field Guide* ($24.95). 9) By participating, entrants agree to abide by these rules and the decisions of the judges. Winner and traveling companion are required to sign an affidavit of eligibility and release, which must be returned within 15 days of notification attempt, or prize is subject to forfeiture, in which case a substitute winner will be selected. By accepting a prize, the winner grants to the National Geographic Society the right to use winner's name, voice, picture and/or likeness for purposes of advertising and publicity without further permission or compensation (except where prohibited by law). Prizes are not redeemable for cash. No prize transfer, assignment or substitution, except by National Geographic for reason of unavailability in which case a prize of equal or greater value will be awarded. By accepting prizes, winners release the National Geographic Society, Ford Motor Company, their agents, affiliates, and subsidiaries from any and all liability for any loss, harm, damages, cost or expense, including without limitation, property damages, personal injury, and/or death, arising out of participation in this promotion or the acceptance or use of any prize. 10) Prizes subject to all federal, state and local laws and regulations. Void where prohibited. All federal, state and local income taxes are the responsibility of the winners.



JAMES A. SUGAR

A Giant Among Trees

And now, the winner and new champion tallest tree in the world: this redwood (above) in a northern California reserve. The Mendocino Tree measures 367 feet 6 inches, notable in an area not known for tall trees, says Steve Sillett of Humboldt State University, who charted its height. "Unless its top breaks off, this record will probably last," he says. The Mendocino Tree is the fourth redwood to claim the top spot since 1995, when the National Geographic Tree held the title at 365 feet 6 inches.



BOTH BY BONNIE BEVERAGE, MALLAKASTRA REGIONAL ARCHAEOLOGICAL PROJECT

■ NGS RESEARCH GRANT

Clues to Albania's Distant Past

Jack L. Davis of the University of Cincinnati expected to find classical ruins, like this second century A.D. Roman council house (above), at Apollonia in Albania. But when he and his U.S.-Albanian team surveyed the fields near the ancient town—founded in the sixth century B.C. by Greece and placed under Roman rule 350 years later—they were amazed to discover thousands of stone tools (right) as much as 40,000 years old.



"They were left by migratory bands of hunters pursuing large animals," says Davis. His group, which worked there the past two years, also mapped a classical cemetery with hundreds of burial mounds.

A "New" Leonardo Goes on View

For the first time in two decades, Easter visitors to Milan will be able to see Leonardo da Vinci's "Last Supper" free of scaffolding and the distortions of earlier retouchings. The masterpiece Leonardo painted between 1494 and 1498 went on public view last year after a 21-year restoration project (GEOGRAPHIC, May 1983). To protect it, only groups of 25 or fewer visitors are allowed in. Pinin Brambilla Barcilon (below) cleaned the work, one flake of paint at a time. "The faces of Christ and the Apostles now convey their participation in the unfolding drama," she says. "Christ has an expression of sadness missing before."



O. LOUIS MAZZATENTA

TEXT BY
BORIS WEINTRAUB

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Tell your doctor if you have liver or kidney problems, or are pregnant. Also, VIOXX should not be used by women in late pregnancy.

VIOXX has been extensively studied in large clinical trials. Commonly reported side effects included upper respiratory infection, diarrhea, nausea and high blood pressure. Report any unusual symptoms to your doctor.

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You should read this information before you start taking VIOXX*. Also, read the leaflet each time you refill your prescription, in case any information has changed. This leaflet provides only a summary of certain information about VIOXX. Your doctor or pharmacist can give you an additional leaflet that is written for health professionals that contains more complete information. This leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss VIOXX when you start taking your medicine and at regular checkups.

What is VIOXX?
VIOXX is a nonsteroidal anti-inflammatory drug (NSAID) that is used to reduce pain and inflammation (swelling and soreness). VIOXX is available as a tablet or a liquid that you take by mouth.

VIOXX is a medicine for:
- relief of osteoarthritis (the arthritis caused by age-related "wear and tear" on bones and joints)
- management of acute pain in adults (like the short-term pain you can get after a dental or surgical operation)
- treatment of menstrual pain (pain during women's monthly periods).

Who should not take VIOXX?
Do not take VIOXX if you:
- have had an allergic reaction such as asthma attacks, hives, or swelling of the throat and face to aspirin or other NSAIDs (for example, ibuprofen and naproxen).
- have had an allergic reaction to rofecoxib, which is the active ingredient of VIOXX, or to any of its inactive ingredients. (See Inactive Ingredients at the end of this leaflet.)

What should I tell my doctor before and during treatment with VIOXX?
Tell your doctor if you are:
- pregnant or plan to become pregnant. VIOXX should not be used in late pregnancy because it may harm the fetus.
- breast-feeding or plan to breast-feed. It is not known whether VIOXX is passed through to human breast milk and what its effects could be on a nursing child.

Tell your doctor if you have:
- kidney disease
- liver disease
- heart failure
- high blood pressure
- had an allergic reaction to aspirin or other NSAIDs
- had a serious stomach problem in the past.

Tell your doctor about:
- any other medical problems or allergies you have now or have had.
- all medicines that you are taking or plan to take, even those you can get without a prescription.

Tell your doctor if you develop:
- ulcer or bleeding symptoms (for instance, stomach burning or black stools, which are signs of possible stomach bleeding).
- unexplained weight gain or swelling of the feet and/or legs.
- skin rash or allergic reactions. If you have a severe allergic reaction, get medical help right away.

How should I take VIOXX?
VIOXX should be taken once a day. Your doctor will decide what dose of VIOXX you should take and how long you should take it. You may take VIOXX with or without food.

Can I take VIOXX with other medicines?
Tell your doctor about all of the other medicines you are taking or plan to take while you are on VIOXX, even other medicines that you can get without a prescription. Your doctor may want to check that your medicines are working properly together if you are taking other medicines such as:
- methotrexate (a medicine used to suppress the immune system)
- warfarin (a blood thinner)
- rifampin (an antibiotic)
- ACE inhibitors (medicines used for high blood pressure and heart failure).

What are the possible side effects of VIOXX?
Serious but rare side effects that have been reported in patients taking VIOXX and/or related medicines have included:

- Serious stomach problems, such as stomach and intestinal bleeding, can occur with or without warning symptoms. These problems, if severe, could lead to hospitalization or death. Although this happens rarely, you should watch for signs that you may have this serious side effect and tell your doctor right away.
- Serious kidney problems occur rarely in patients taking NSAIDs.
- Severe liver problems occur rarely in patients taking NSAIDs. Tell your doctor if you develop symptoms of liver problems. These include nausea, tiredness, itching, tenderness in the right upper abdomen, and flu-like symptoms.

More common, but less serious side effects reported with VIOXX have included the following:

Upper and/or lower respiratory infection and/or inflammation
Headache
Dizziness
Diarrhea
Nausea and/or vomiting
Heartburn, stomach pain and upset
Swelling of the legs and/or feet
High blood pressure
Back pain
Tiredness
Urinary tract infection.

These side effects were reported in at least 2% of osteoarthritis patients receiving daily doses of VIOXX 12.5 mg to 25 mg in clinical studies.

The side effects described above do not include all of the side effects reported with VIOXX. Do not rely on this leaflet alone for information about side effects. Your doctor or pharmacist can discuss with you a more complete list of side effects. Any time you have a medical problem you think may be related to VIOXX, talk to your doctor.

What else can I do to help manage my osteoarthritis pain?
Talk to your doctor about:
- Exercise
- Controlling your weight
- Hot and cold treatments
- Using support devices.

What else should I know about VIOXX?
This leaflet provides a summary of certain information about VIOXX. If you have any questions or concerns about VIOXX, osteoarthritis or pain, talk to your health professional. Your pharmacist can give you an additional leaflet that is written for health professionals.

Do not share VIOXX with anyone else; it was prescribed only for you. It should be taken only for the condition for which it was prescribed.

Keep VIOXX and all medicines out of the reach of children.

Inactive Ingredients:

Oral suspension: citric acid (monohydrate), sodium citrate (dihydrate), sorbitol solution, strawberry flavor, xanthan gum, sodium methylparaben, sodium propylparaben.

Tablets: croscarmellose sodium, hydroxypropyl cellulose, lactose, magnesium stearate, microcrystalline cellulose, and yellow ferric oxide.

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Forum

Readers of the December issue were transported from the rolling plains of the Serengeti to the dark forests of the Brothers Grimm fairy tales. "The sensational photographs catch the essence of the cheetah very well," wrote one reader. Another said: "Now 25, I find myself anxious to read the 'real' stories the way the brothers originally intended . . . but leave the lights on!"

Cheetahs

As a lifelong and fairly well traveled hunter and conservationist, I was surprised—even appalled—by references to sport hunting for cheetahs. Fair-chase game species are animals that either test the hunter's skills (i.e., natural knowledge, stalking, tracking, marksmanship, perseverance, courage) or provide meat for the table. At least under normal conditions the cheetah is not difficult to find, it poses no physical threat to humans, and, like all cats, I'm sure it's barely edible. To those who wish to bring a cheetah home with their lion and Cape buffalo to remind them of their wonderful African safari, may I recommend Kodachrome?

SILVIO CALABI
Camden, Maine

Most mounted animals are a cherished memory of an outdoor experience and not a forgotten souvenir mistreated by the smoke of cigar-toting partygoers. Perhaps the author should research how much of the world's conservation efforts are funded by hunters or their organizations. One only has to look at Teddy Roosevelt, who hunted big game and established national parks in the United States to preserve unique habitats and their wildlife from human encroachment—not from hunting.

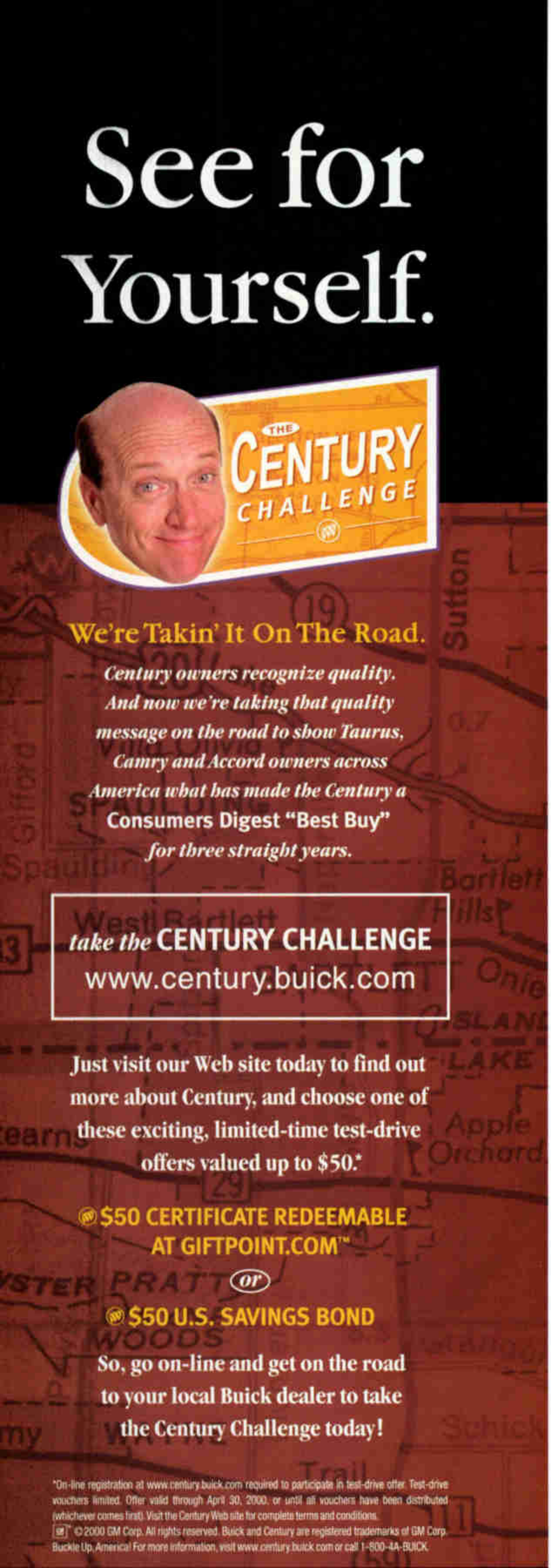
ANNA FONTANA
Cranbrook, British Columbia

A few additional facts about Namibia's cheetah-hunting compact should be noted. The compact provides that a minimum $2,500 trophy fee will be charged and an additional $1,000 surcharge will go exclusively to cheetah conservation. The compact also provides that no females or young will be killed. The surcharges have already helped fund many conservation efforts in Namibia.

JOHN J. JACKSON III
Director, Cheetah Initiative
Metairie, Louisiana

Consumptive use of wildlife, especially in the case of the cheetah, is not the answer to solving Namibia's wildlife-human conflicts. Westerners continue to promote the utilitarian use of wildlife from which





only wealthy, foreign trophy hunters or white landowners receive any benefit. Where was the voice of indigenous Namibians in your article?

CRYSTAL MILLER
Falls Creek, Pennsylvania

Your article was probably accurate in describing the Cheetah Conservation Fund and AfriCat as sometimes having a clash of egos. But this does not detract from the work they are doing or their common goal of getting man and nature to coexist. While the CCF does more research, such as tracking cheetahs, the Hanssens of AfriCat operate a school on the guest farm and expose travelers to the plight of the African cats. Both methods appear to be working, and the cats of Namibia are better off with both organizations.

TOM RUISINGER
Lenexa, Kansas

It is sickening to hear about the decline of African animals due to man's encroachment upon the land. One solution that is never considered—despite all the ingenious birth-control plans proposed for African elephants—is birth control for humans.

RHONDA PIASECKI
West Linn, Oregon

Florida Keys

Frank Deford's article dusted off some rich images of when I spent the winters of 1974 and 1975 in Key West. The sunsets at Mallory Square, the Bird Cage Bar, the Bull and Whistle, and a steamy atmosphere in which one could fall in and out of love as regularly as the changing of the tides. . . . Ah, what memories!

BOB BEER
Telluride, Colorado

The Florida Keys paradise? Rather one long worn-out old whorehouse.

B. MENDES
Seymour, Connecticut

Regarding encroachment on key deer and the reefs, the best advice remains that received from an emergency room nurse after I was stung picking up a nereid worm without gloves from the waters off Marathon Key: "Leave the animals alone!"

ROBERT ALAN SOLTIS
San Diego, California

I enjoyed the article, but I must protest the use of the expression "Jersey shore" as a generic derogatory descriptive. We are lucky to have here over 120 miles of beautiful Atlantic coastline, as well as countless miles of marsh shoreline. Mr. Deford cannot have explored these miles if he thinks the Jersey shore lacks "backdrop and variety," for those terms capture the essence of New Jersey's uniqueness.

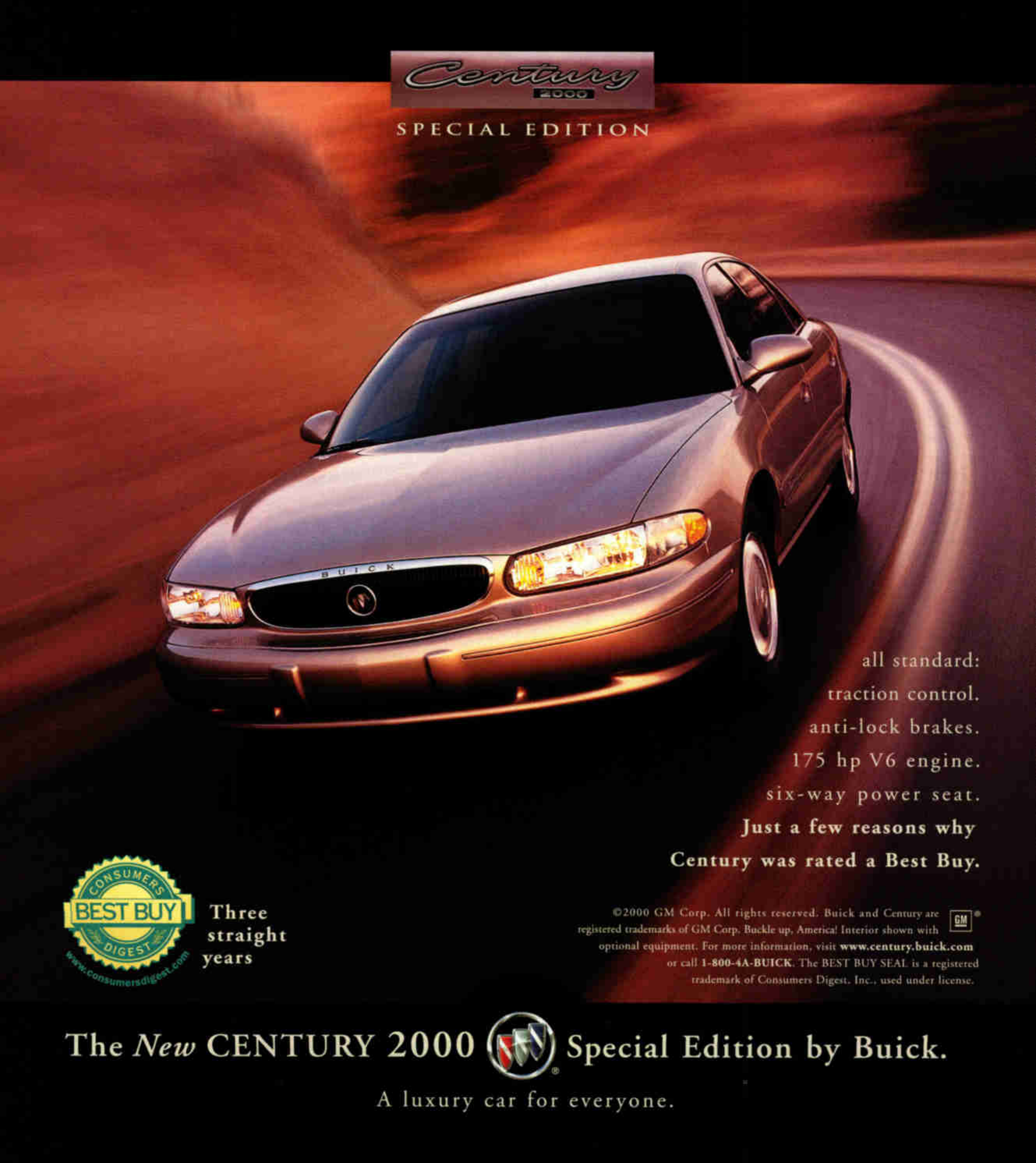
LYNN MOCERI
Stone Harbor, New Jersey

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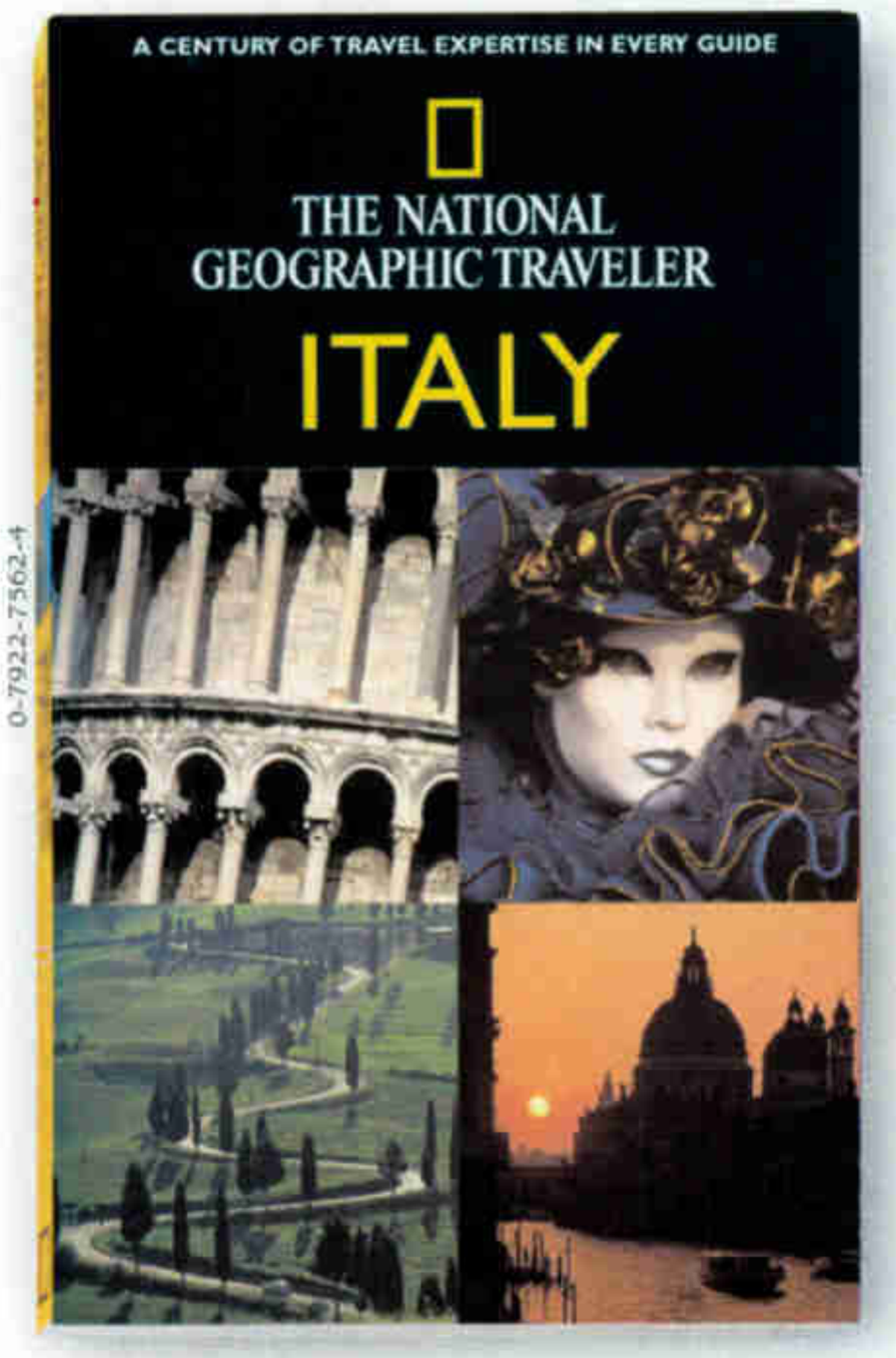
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whether dusk or dawn. I catch the sunrise flash maybe twice a year. And in Wyoming we're about as far from an ocean horizon as it's possible to get.

CAROL ALDINGER
Green River, Wyoming

Ancient Greece

The word "impatient" was one of the more flattering adjectives used to describe the wealthy German businessman and amateur archaeologist Heinrich Schliemann. One must admit that during his lifetime he was called many ugly names in the some 18 languages he spoke. However, were it not for Schliemann's persistent dream of finding Homer's Troy and its treasures, that ancient site might still be only part of a myth, and Homer our *only* source of information about the era.

LEE E. GINGERY
Shenandoah, Iowa

Caroline Alexander's superb article brought to mind a family trip to Mycenae in 1965. Our guide was Gen. Alex Mélas, Heinrich Schliemann's only surviving grandson, who brimmed with anecdotes imparted by his grandmother, Sophia, concerning the quest for Troy and Mycenae. General Mélas never accepted the reality that the Golden Mask of Agamemnon (pages 68-9) was incorrectly identified. According to him, Schliemann watched as his wife, Sophia, using her penknife and fingernails, uncovered a skeleton with a face preserved by the golden mask. She gently lifted the mask, and "after 30 centuries, she saw Agamemnon smiling at her for a few seconds before his face crumbled into dust."

WILLARD C. MACFARLAND
Orchard Park, New York

The author makes a good point about the revitalization of Greek civilization in the eighth century B.C., saying that "perhaps the characterization of the independent-minded hero Achilles and the *Iliad*'s interest in different types of leadership reflect associated political change." I would argue that the *Iliad* was at least partly—if not largely—responsible for the revitalization after Greece's dark age. The storytellers who kept alive Homer's patriotic war epic most likely helped inspire their listeners to achieve in Athens in the fifth century B.C. the greatest civilization of antiquity.

DENNIS B. LEDDEN
Butler, Pennsylvania

The Brothers Grimm

Author Thomas O'Neill mentioned the bronze statue of the Brothers Grimm in front of the *Rathaus,* with Jacob standing and Wilhelm sitting. When I was growing up in Hanau, we told out-of-town cousins and friends that at the stroke of midnight, Jacob and Wilhelm would change places.

HERMINE RUSSELL
Winfield, Alabama

As I finished reading about the Brothers Grimm, I looked at the firelight flickering through the glass



door of the woodstove, then through the German lace curtains at the snow dusting the spruce tree outside the window. As our two cuckoo clocks announced the hour, the house was transformed into a cottage and the trees in the yard into a deep forest. This morning I visited the library and checked out copies of the fairy tales—in German, English, and Italian. Thank you for reminding me of the joy of curling up by the fire with a good fairy tale.

NOEL ZAUGG
Sugar City, Idaho

Mr. O'Neill writes that "In *Cinderella* (1950) Disney frosted the plot by adding a carriage that turns into a pumpkin at the stroke of midnight." In Charles Perrault's variant of the Cinderella story, first published in 1697, the pumpkin plays a prominent role as the beautiful carriage and indeed turns back into a pumpkin at midnight. There is no doubt that a lot of stories were sweetened by Disney, but this particular device cannot be credited to the filmmaker.

ALEXANDER GIMELBRANT
Lexington, Kentucky

You're right; we have pumpkin on our face.

Storytelling is one of the most wonderful ways of preserving cultural values. It is also proof of the fact that basic moral concepts, like kindness, respect, and honor, are universal in nature.

RAFAEL VEGA-FELICIANO
Doylestown, Pennsylvania

Since I was seven years old, there has been a Grimm wolf under my bed. Although your author tried, I don't think he properly conveyed the sheer terror the Grimm stories inflict in youngsters' hearts. Still, I grew up thinking the brothers were my uncles and treasure the memories their stories brought.

TONY GRIMM
Las Vegas, Nevada

The magical photographs by Gerd Ludwig and the informative text by Thomas O'Neill were greatly appreciated, but I wish ballet was included in the list of media adaptations. What would the major ballet companies do without "Sleeping Beauty" and "Cinderella"?

JEAN D. CLARK-GRANEY
Hancock, New Hampshire

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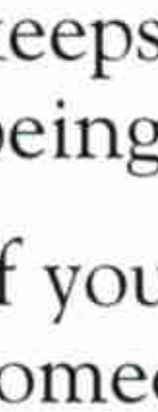
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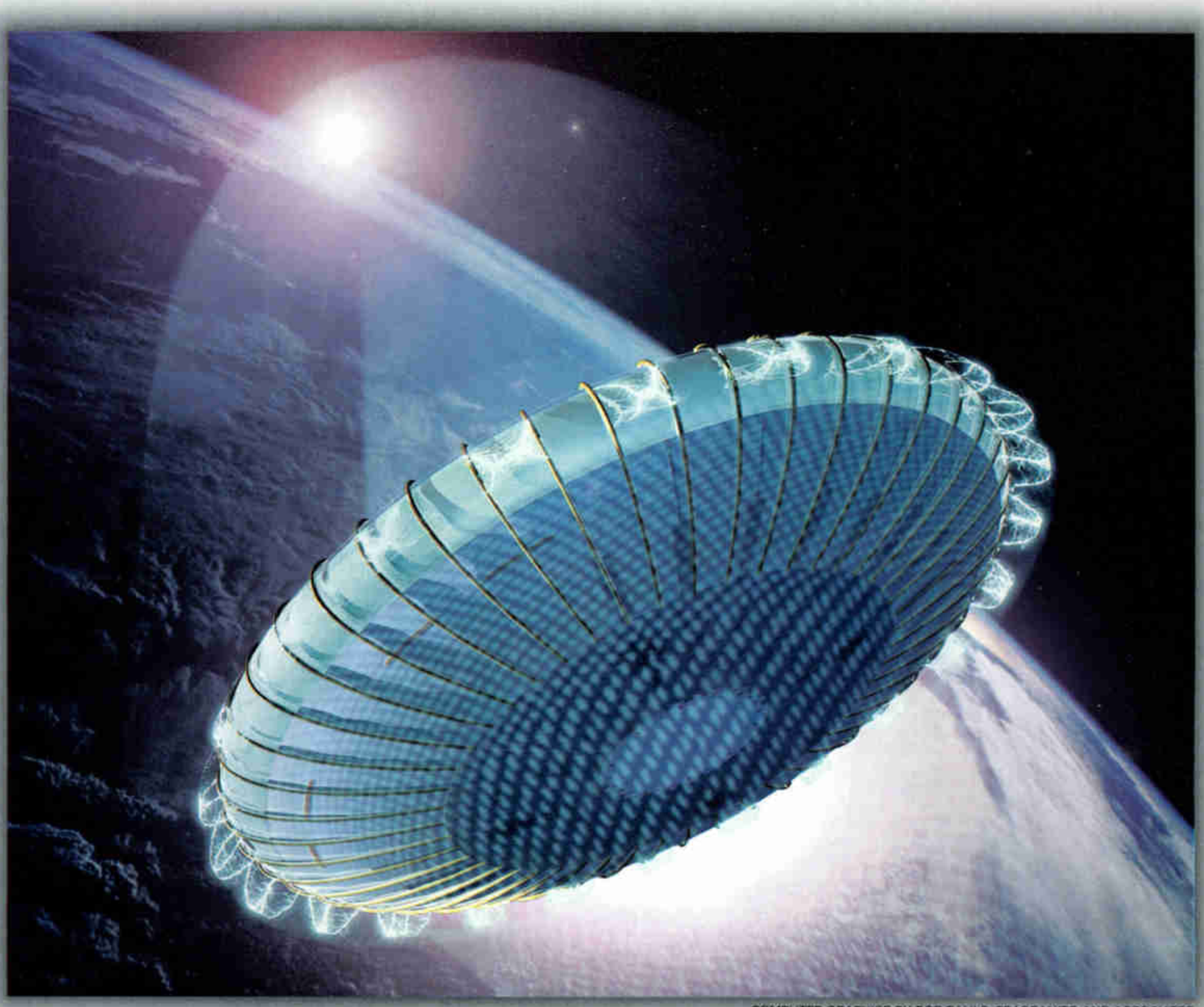
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■ EXPLORER

Beam Me Up, Scotty!

Lifted into orbit by microwave energy beamed from a solar-powered satellite that generates more electricity than the Grand Coulee Dam, a spacecraft carrying 12 passengers exits Earth's atmosphere at full throttle—18,000 miles an hour. Science fiction? Science fact, says David Royle, executive producer of EXPLORER's *Quest for Space.* Designs for such a microwave "lightcraft" are already undergoing tests at New York's Rensselaer Polytechnic Institute. "It's no longer the dawn of space travel; we are now in full day," Royle declares. "In the not-so-distant future our dreams of space exploration could become reality." The show envisions a time when vehicles will travel from Earth in search of water on distant moons, mineral riches on asteroids, and extraterrestrial life. A new space race is on, says Royle. This time, it's not between East and West but between free enterprise and government space programs.

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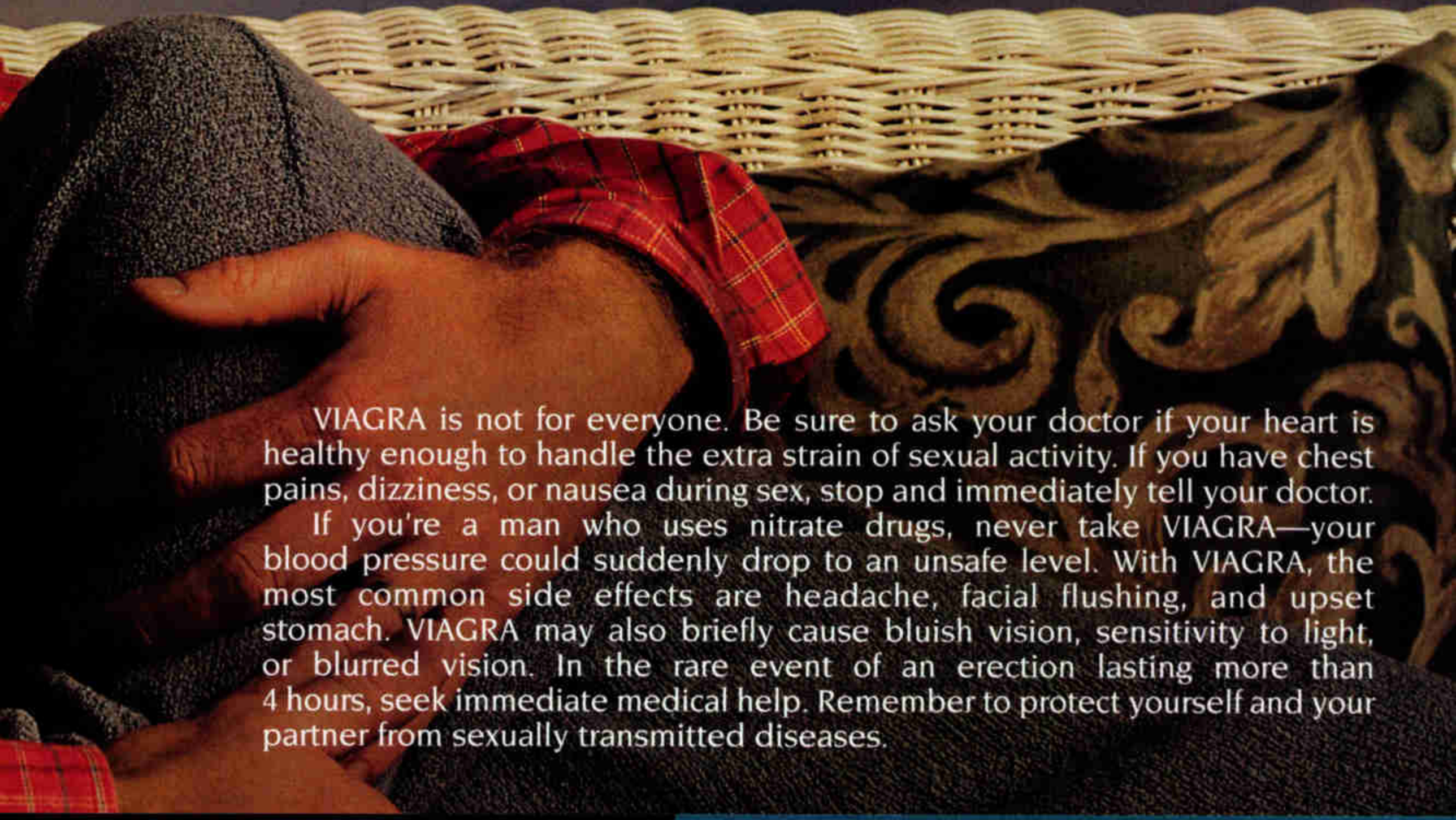
When my husband first started experiencing erectile dysfunction (ED), he didn't want to admit there was anything wrong. But when it started to put a real strain on our relationship, he talked to his doctor about VIAGRA.

—VIAGRA has shown improvement in erectile function in 4 out of 5 men compared with 1 out of 4 for sugar tablets

—More than 15 million prescriptions written in the United States*

—Effective and well tolerated in a variety of patients

It's great what VIAGRA has done for him—and for us.



VIAGRA is not for everyone. Be sure to ask your doctor if your heart is healthy enough to handle the extra strain of sexual activity. If you have chest pains, dizziness, or nausea during sex, stop and immediately tell your doctor.

If you're a man who uses nitrate drugs, never take VIAGRA—your blood pressure could suddenly drop to an unsafe level. With VIAGRA, the most common side effects are headache, facial flushing, and upset stomach. VIAGRA may also briefly cause bluish vision, sensitivity to light, or blurred vision. In the rare event of an erection lasting more than 4 hours, seek immediate medical help. Remember to protect yourself and your partner from sexually transmitted diseases.

Love life again.

VIAGRA®
(sildenafil citrate) tablets

L o v e l i f e a g a i n.



PATIENT SUMMARY OF INFORMATION ABOUT

VIAGRA®
(sildenafil citrate) tablets

This summary contains important information about VIAGRA®. It is not meant to take the place of your doctor's instructions. Read this information carefully before you start taking VIAGRA. Ask your doctor or pharmacist if you do not understand any of this information or if you want to know more about VIAGRA.

This medicine can help many men when it is used as prescribed by their doctors. However, VIAGRA is not for everyone. It is intended for use only by men who have a condition called erectile dysfunction. **VIAGRA must never be used by men who are taking medicines that contain nitrates of any kind, at any time. This includes nitroglycerin. If you take VIAGRA with any nitrate medicine your blood pressure could suddenly drop to an unsafe or life threatening level.**

What Is VIAGRA?

VIAGRA is a pill used to treat erectile dysfunction (impotence) in men. It can help many men who have erectile dysfunction get and keep an erection when they become sexually excited (stimulated).

You will not get an erection just by taking this medicine. VIAGRA helps a man with erectile dysfunction get an erection only when he is sexually excited.

How Sex Affects the Body

When a man is sexually excited, the penis rapidly fills with more blood than usual. The penis then expands and hardens. This is called an erection. After the man is done having sex, this extra blood flows out of the penis back into the body. The erection goes away. If an erection lasts for a long time (more than 6 hours), it can permanently damage your penis. You should call a doctor immediately if you ever have a prolonged erection that lasts more than 4 hours.

Some conditions and medicines interfere with this natural erection process. The penis cannot fill with enough blood. The man cannot have an erection. This is called erectile dysfunction if it becomes a frequent problem.

During sex, your heart works harder. Therefore sexual activity may not be advisable for people who have heart problems. Before you start any treatment for erectile dysfunction, ask your doctor if your heart is healthy enough to handle the extra strain of having sex. If you have chest pains, dizziness or nausea during sex, stop having sex and immediately tell your doctor you have had this problem.

How VIAGRA Works

VIAGRA enables many men with erectile dysfunction to respond to sexual stimulation. When a man is sexually excited, VIAGRA helps the penis fill with enough blood to cause an erection. After sex is over, the erection goes away.

VIAGRA Is Not for Everyone

As noted above (*How Sex Affects the Body*), ask your doctor if your heart is healthy enough for sexual activity.

If you take any medicines that contain nitrates—either regularly or as needed—you should never take VIAGRA. If you take VIAGRA with any nitrate medicine or recreational drug containing nitrates, your blood pressure could suddenly drop to an unsafe level. You could get dizzy, faint, or even have a heart attack or stroke. Nitrates are found in many prescription medicines that are used to treat angina (chest pain due to heart disease) such as:

- nitroglycerin (sprays, ointments, skin patches or pastes, and tablets that are swallowed or dissolved in the mouth)
- isosorbide mononitrate and isosorbide dinitrate (tablets that are swallowed, chewed, or dissolved in the mouth)

Nitrates are also found in recreational drugs such as amyl nitrate or nitrite ("poppers"). If you are not sure if any of your medicines contain nitrates, or if you do not understand what nitrates are, ask your doctor or pharmacist.

VIAGRA is only for patients with erectile dysfunction. VIAGRA is not for newborns, children, or women. Do not let anyone else take your VIAGRA. VIAGRA must be used only under a doctor's supervision.

What VIAGRA Does Not Do

- VIAGRA does not cure erectile dysfunction. It is a treatment for erectile dysfunction.
- VIAGRA does not protect you or your partner from getting sexually transmitted diseases, including HIV—the virus that causes AIDS.
- VIAGRA is not a hormone or an aphrodisiac.

What To Tell Your Doctor Before You Begin VIAGRA

Only your doctor can decide if VIAGRA is right for you. VIAGRA can cause mild, temporary lowering of your blood pressure. You will need to have a thorough medical exam to diagnose your erectile dysfunction and to find out if you can safely take VIAGRA alone or with your other medicines. Your doctor should determine if your heart is healthy enough to handle the extra strain of having sex.

Be sure to tell your doctor if you:

- have ever had any heart problems (e.g., angina, chest pain, heart failure, irregular heart beats, or heart attack)
- have ever had a stroke
- have low or high blood pressure
- have a rare inherited eye disease called retinitis pigmentosa
- have ever had any kidney problems
- have ever had any liver problems
- have ever had any blood problems, including sickle cell anemia or leukemia
- are allergic to sildenafil or any of the other ingredients of VIAGRA tablets
- have a deformed penis, Peyronie's disease, or ever had an erection that lasted more than 4 hours
- have stomach ulcers or any types of bleeding problems
- are taking any other medicines

VIAGRA and Other Medicines

Some medicines can change the way VIAGRA works. Tell your doctor about **any medicines** you are taking. Do not start or stop taking any medicines before checking with your doctor or pharmacist. This includes prescription and nonprescription medicines or remedies. Remember, VIAGRA should never be used with medicines that contain nitrates (see *VIAGRA Is Not for Everyone*). If you are taking a protease inhibitor, your dose may be adjusted (please see *Finding the Right Dose for You.*) VIAGRA should not be used with any other medical treatments that cause erections. These treatments include pills, medicines that are injected or inserted into the penis, implants or vacuum pumps.

Finding the Right Dose for You

VIAGRA comes in different doses (25 mg, 50 mg and 100 mg). If you do not get the results you expect, talk with your doctor. You and your doctor can determine the dose that works best for you.

- Do not take more VIAGRA than your doctor prescribes.
- If you think you need a larger dose of VIAGRA, check with your doctor.
- VIAGRA should not be taken more than once a day.

If you are older than age 65, or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg) of VIAGRA. If you are taking protease inhibitors, such as for the treatment of HIV, your doctor may recommend a 25 mg dose and may limit you to a maximum single dose of 25 mg of VIAGRA in a 48 hour period.

How To Take VIAGRA

Take VIAGRA about one hour before you plan to have sex. Beginning in about 30 minutes and for up to 4 hours, VIAGRA can help you get an erection if you are sexually excited. If you take VIAGRA after a high-fat meal (such as a cheeseburger and french fries), the medicine may take a little longer to start working. VIAGRA can help you get an erection when you are sexually excited. You will not get an erection just by taking the pill.

Possible Side Effects

Like all medicines, VIAGRA can cause some side effects. These effects are usually mild to moderate and usually don't last longer than a few hours. Some of these side effects are more likely to occur with higher doses. The most common side effects of VIAGRA are headache, flushing of the face, and upset stomach. Less common side effects that may occur are temporary changes in color vision (such as trouble telling the difference between blue and green objects or having a blue color tinge to them), eyes being more sensitive to light, or blurred vision.

In rare instances, men have reported an erection that lasts many hours. You should call a doctor immediately if you ever have an erection that lasts more than 4 hours. If not treated right away, permanent damage to your penis could occur (see *How Sex Affects the Body*).

Heart attack, stroke, irregular heart beats, and death have been reported rarely in men taking VIAGRA. Most, but not all, of these men had heart problems before taking this medicine. It is not possible to determine whether these events were directly related to VIAGRA.

VIAGRA may cause other side effects besides those listed on this sheet. If you want more information or develop any side effects or symptoms you are concerned about, call your doctor.

Accidental Overdose

In case of accidental overdose, call your doctor right away.

Storing VIAGRA

Keep VIAGRA out of the reach of children. Keep VIAGRA in its original container. Store at room temperature, 59°-86°F (15°-30°C).

For More Information on VIAGRA

VIAGRA is a prescription medicine used to treat erectile dysfunction. Only your doctor can decide if it is right for you. This sheet is only a summary. If you have any questions or want more information about VIAGRA, talk with your doctor or pharmacist, visit www.viagra.com, or call 1-888-4VIAGRA.

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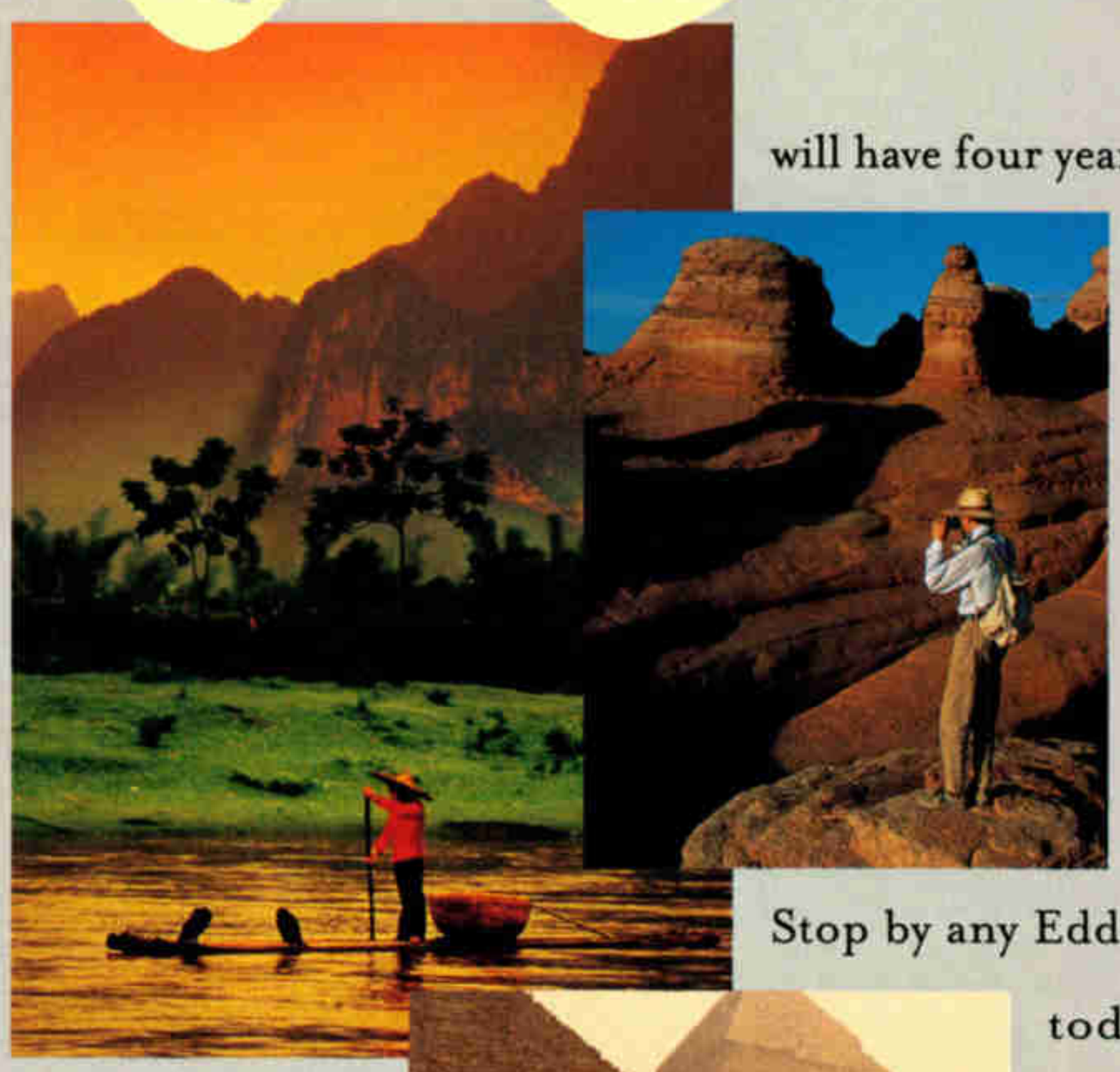
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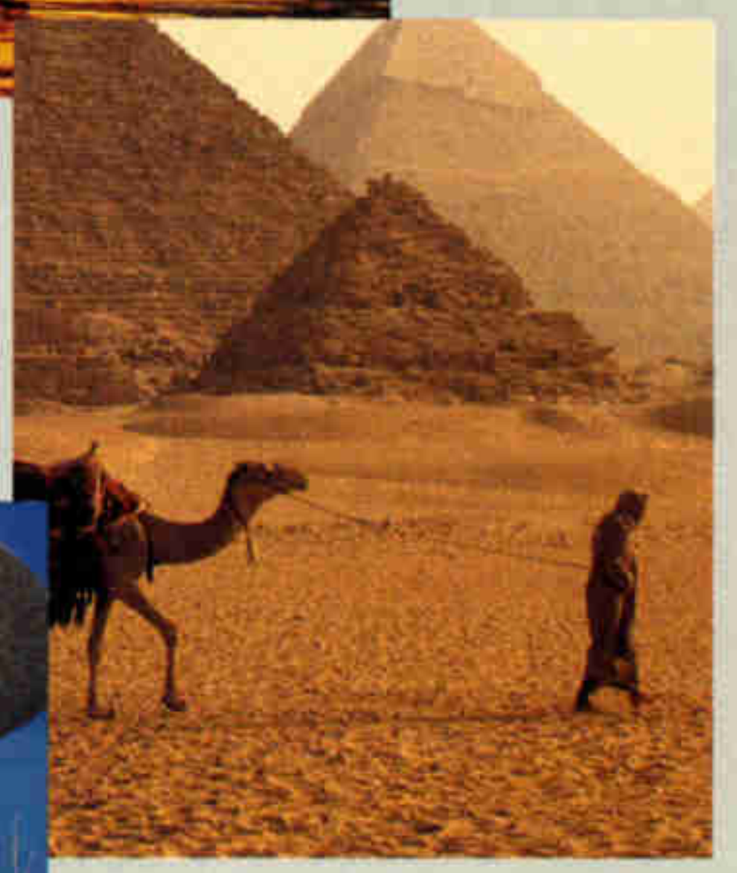
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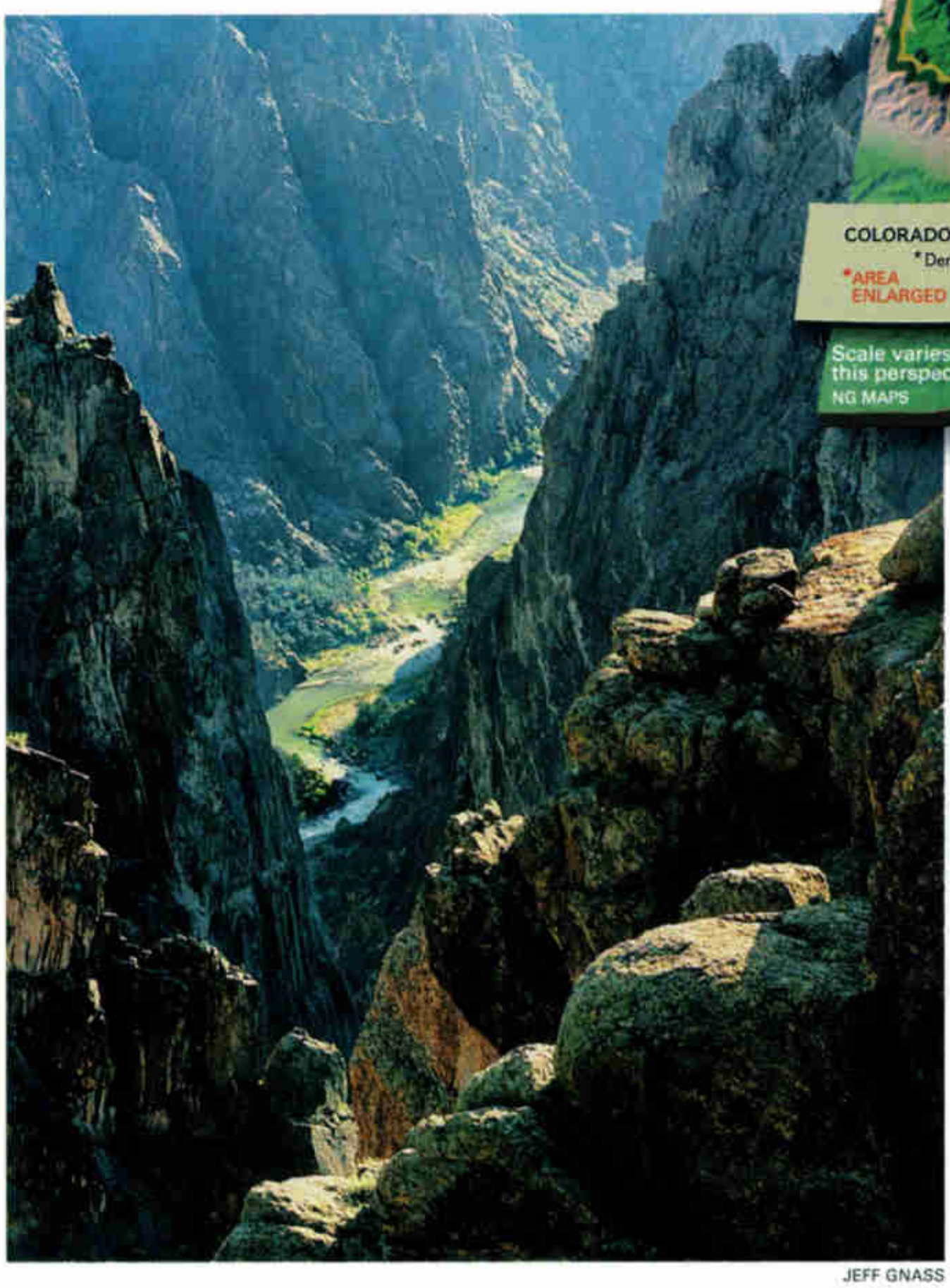
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NATIONAL GEOGRAPHIC

Earth Almanac



JEFF GNASS

Newest U.S. Park: Black Canyon of the Gunnison

"Hereto was unfolded view after view of the most wonderfull, the most thrilling of rock exposers." In 1883 H. C. Wright, part of a surveying team, was captivated by the 53-mile-long Black Canyon gorge, which plummets 2,700 feet into the Gunnison River in Colorado. Wright wasn't the last to feel that way. Last October the Black Canyon of the Gunnison became the nation's 55th national park; it had been a national monument since 1933.

At 30,000 acres Black Canyon is one of the United States' smallest national parks. Today most parks are created wholly from federal land, but Black Canyon is an anomaly: The National Park Service plans to use a conservation easement along with funds from Congress to purchase 3,000 acres of private land that abuts the southern edge of the park. "If homes were built there, it would totally change the experience at Black Canyon," says park superintendent Sheridan Steele. "The land slopes up and away from the canyon, and the development would be visible to everyone."

Ken Gale, former mayor of nearby Montrose, worked for 14 years to create the park. "I think it's more spectacular than the Grand Canyon—the walls are so sheer," he says. He adds that "trout fishing in the Gunnison is great," and notes that former President Jimmy Carter has floated and fished the river several times.

Thornbugs Still Need Mom's Help

Strangely shaped natives of Central and South America, adult thornbugs resemble plant thorns, an adaptation providing great protection. But it's thornbug communication that has intrigued University of Missouri researcher Rex Cocroft for six years. Bugs in the nymph stage are soft, vulnerable to wasps and other predators. The nymphs cluster together on a plant stem with their mother close by. "If a predator approaches, they produce a vibration within their bodies that travels through the stem to their mother," Cocroft says. "She marches up to the intruder and delivers a strong kick with her hind legs."



BRIAN KENNEY, PLANET EARTH PICTURES

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Rescuing a Caribbean Holdout

Probably the world's rarest snakes, Antiguan racers number only about a hundred. Mongooses imported to Antigua around 1900 to control rats instead wiped out the snakes. Five years ago researchers discovered a few racers on an offshore island—but they also found rats, shipboard stowaways, that were eating the harmless snakes. Fauna and Flora International and other groups have eradicated the rats, and the racers are making a comeback.

JOHN CANCALOSI



MAX GIBBS, OXFORD SCIENTIFIC FILMS

Rapid Arrivals Departing Quickly

It takes millions of years for new species to arise, right? Think again. Only a few species of cichlids (left) survived in Africa's Lake Victoria by the late Pleistocene, when the lake nearly dried up. As it refilled over the next 14,000 years—an evolutionary eyeblink—the lake's few cichlids evolved into 400 plus species. But now Victoria's cichlids are rapidly going extinct due to introduced fish, pollution, habitat loss, and overfishing.



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Rescuing Swift Foxes Without Red Tape

Called *senopah* by the Blackfeet Indians, the swift fox was long a touchstone of Blackfeet culture. But early this century the species disappeared from the Blackfeet Reservation in Montana and nearly all the Great Plains. The foxes were done in by hunting and by eating poisoned meat intended for coyotes and wolves.

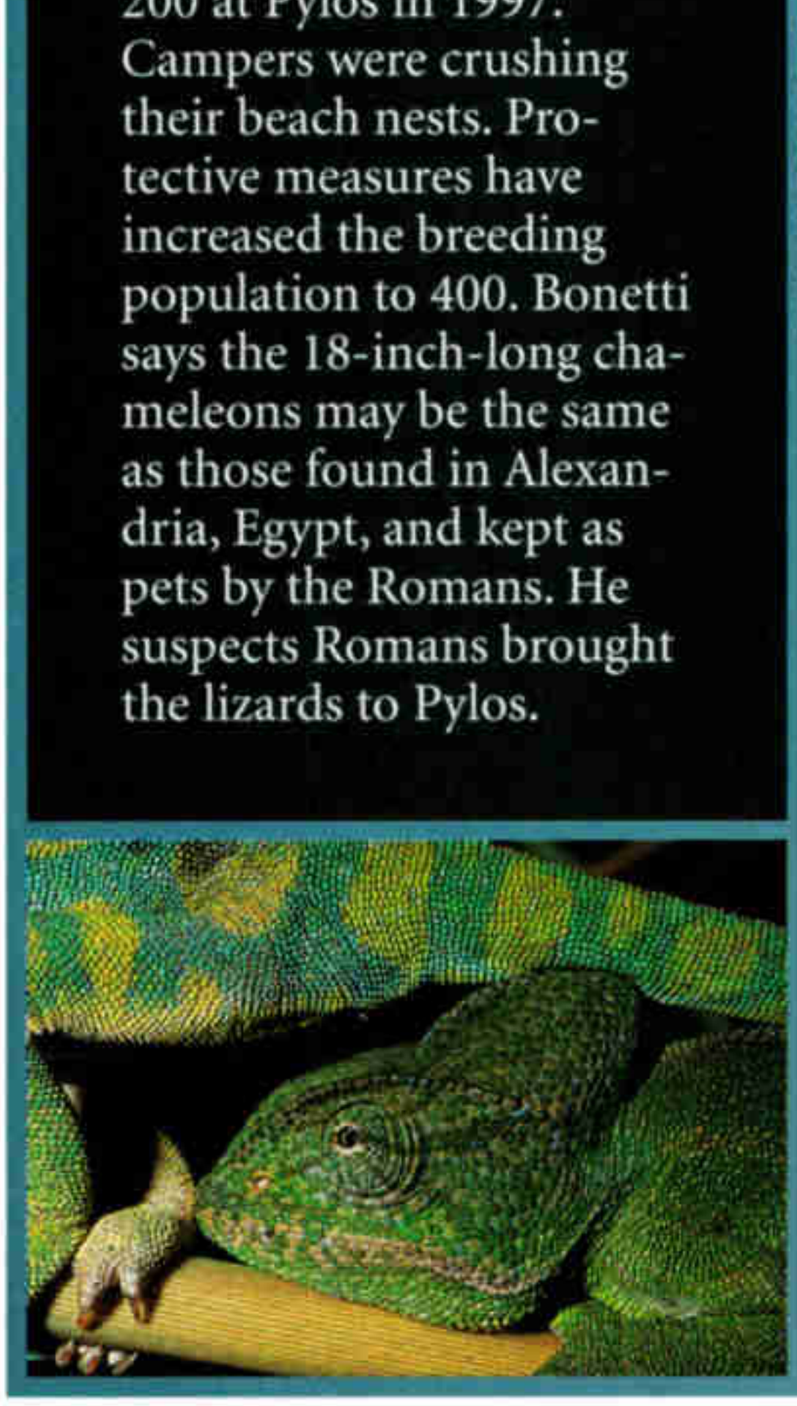
Not waiting for federal action, in August 1998 the Blackfeet and their partners, Defenders of Wildlife, released on the reservation 14 pairs of swift foxes from a captive-breeding center in Canada. After more releases they hope to have 250 pairs by 2003. One pair stays close to a temporary shelter (above). "It's a very friendly species," says Ira Newbreast, manager of the Blackfeet Fish and Wildlife Department. "Our young people have lost touch with senopah. We're going to change that with a program in our schools."



JEFF AND ALEXA HENRY

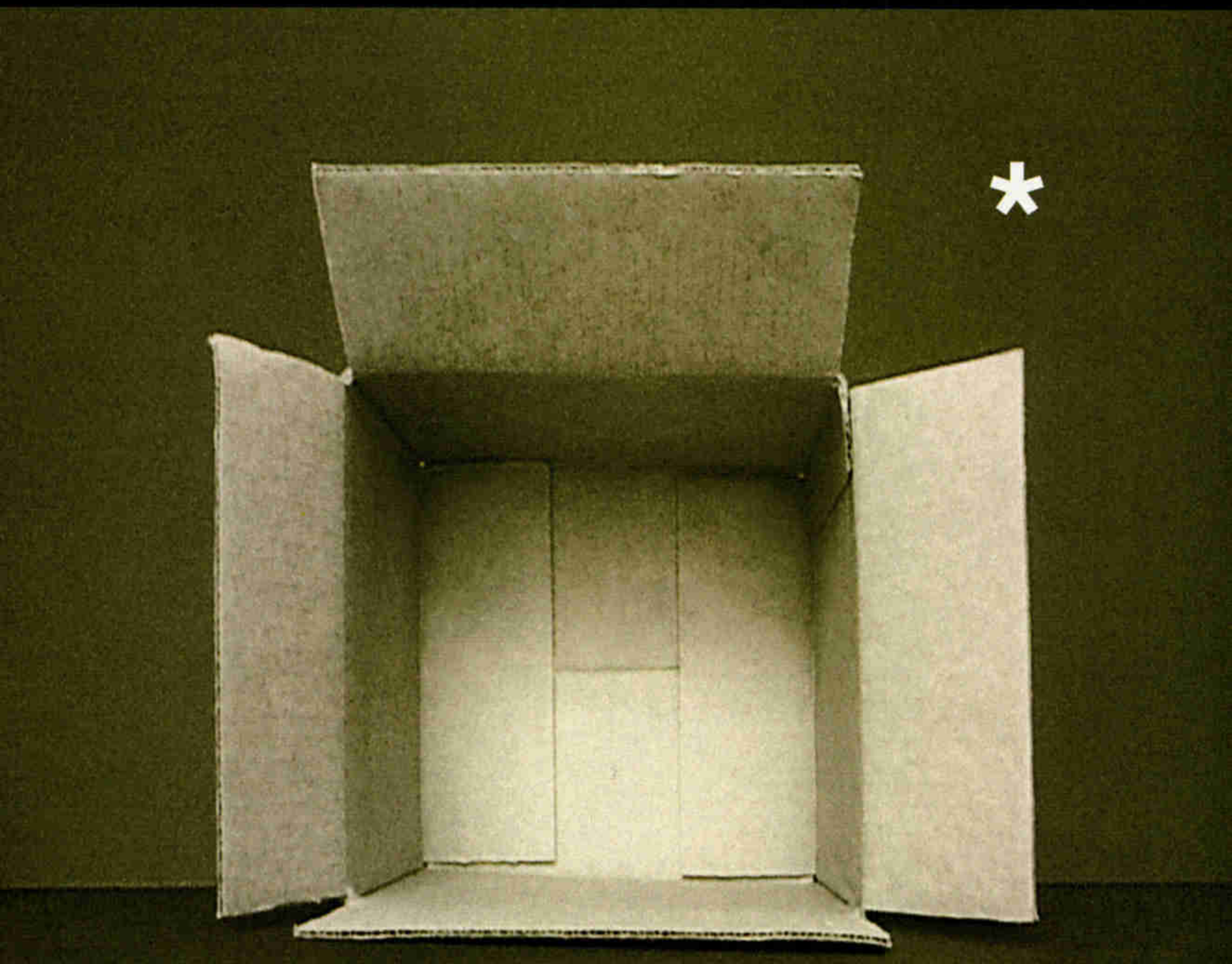
Greco-Roman Chameleons?

No African chameleons were thought to live in Greece until biologists Andrea Bonetti and Giorgos Chiras found about 200 at Pylos in 1997. Campers were crushing their beach nests. Protective measures have increased the breeding population to 400. Bonetti says the 18-inch-long chameleons may be the same as those found in Alexandria, Egypt, and kept as pets by the Romans. He suspects Romans brought the lizards to Pylos.





BOTH BY ANDREA BONETTI



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WILDLIFE AS CANON SEES IT

A hatchling bog turtle, just three centimeters in length, steps across a mossy patch. Having recently emerged from the nest cavity where its mother deposited her three eggs, the vulnerable hatchling finds refuge beneath clumps of hanging moss and sedge grass. On cool days, it will bask in the sun to warm itself, but if disturbed the little turtle digs quickly into the moss and mud to hide. The bright yellow blotches on either side of its head will remain a striking feature even as an adult. Loss or pollution of wetland habitat, natural succession, and illegal collecting for the pet trade threaten the survival of the bog turtle.

As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.



Bog Turtle *(Clemmys muhlenbergii)*
Size: Adult carapace length, 8.5 - 11.4 cm
Weight: 110 - 176 g
Habitat: Spring-fed bogs, marshes and wet meadows in the eastern United States
Surviving number: Unknown; populations declining and discontinuous throughout its range

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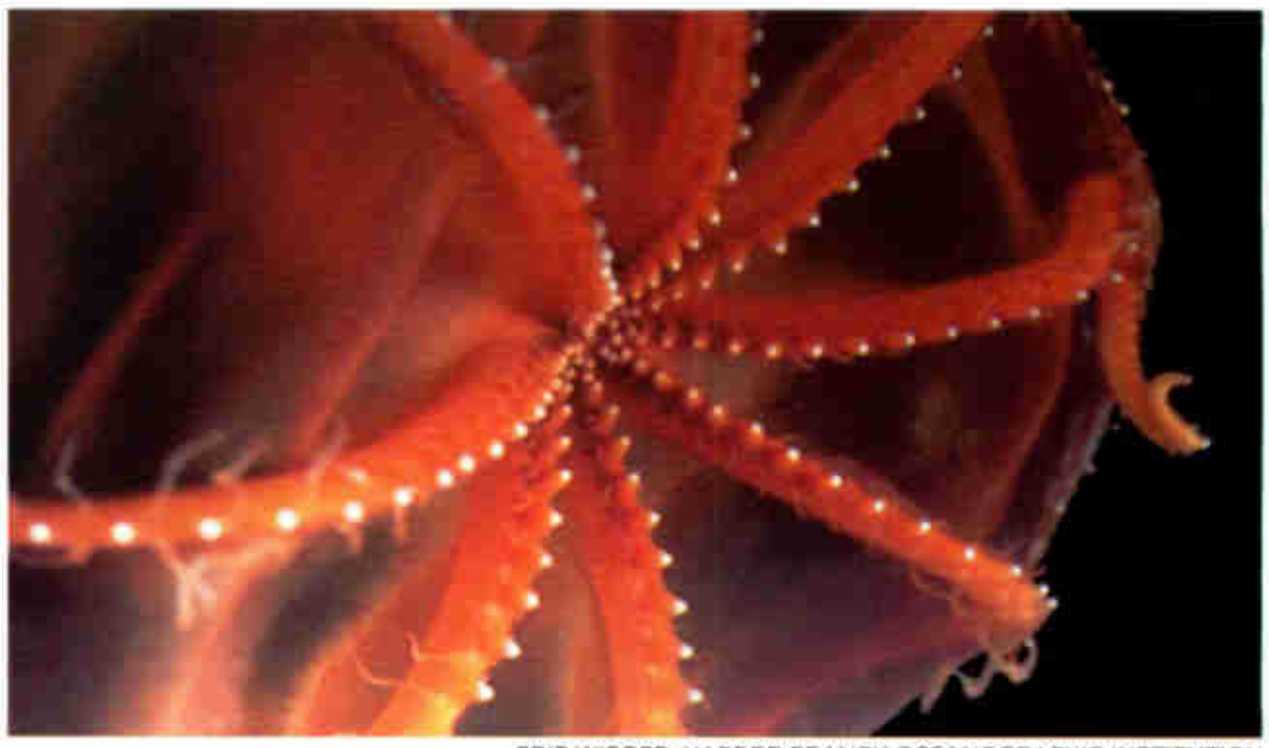
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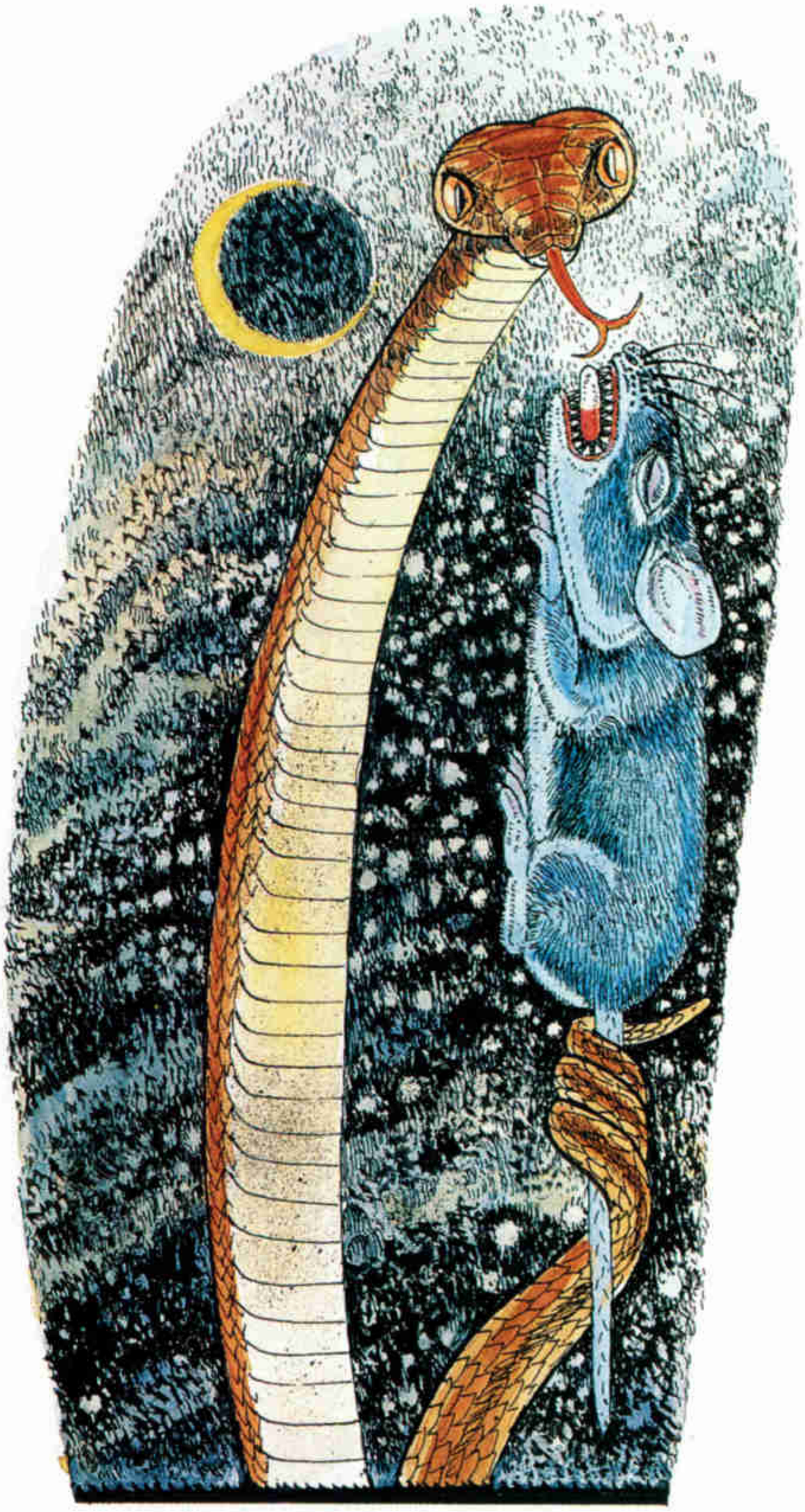
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Octopus Glows in the Dark

Octopuses use their suckers to grip seafloor objects in shallow water. But 2,700 feet deep in the Gulf of Maine, researchers Edie Widder and Sonke Johnsen found a free-swimming octopus whose suckers no longer grasp: They have evolved into light-producing organs. The octopuses use this bioluminescence to signal each other or attract prey. The biologists placed this specimen in a darkroom aboard their research vessel and photographed it when it glowed.



EDIE WIDDER, HARBOR BRANCH OCEANOGRAPHIC INSTITUTION



Common Pain Reliever—Rx for a Biological Migraine?

Traps, electric fences, detector dogs—nothing stops brown tree snakes, invaders from the southwest Pacific that came to Guam after World War II, probably by ship. The snakes have virtually destroyed Guam's native birds, and researchers fear the predators will spread to other islands. There's a new weapon: acetaminophen, a compound in pain relievers. *It's toxic* to these snakes, as Peter J. Savarie of the USDA's National Wildlife Research Center has discovered. On Guam a team is inserting tablets into dead mice and tracking electronically tagged snakes to see if they take the bait.



ART BY JACK UNRUH (LEFT); JOEL SARTORE

Bird Aid Means No Red Tape

Depleted by conversion of grasslands to croplands, lesser prairie chickens have represented a stick and a carrot to farmers. In 1999 landowners avoided federal regulation when a decision to declare the birds endangered was deferred. Now farmers who help restore prairie chicken habitat are paid and will be exempt from future regulations if the birds are listed.

TEXT BY JOHN L. ELIOT

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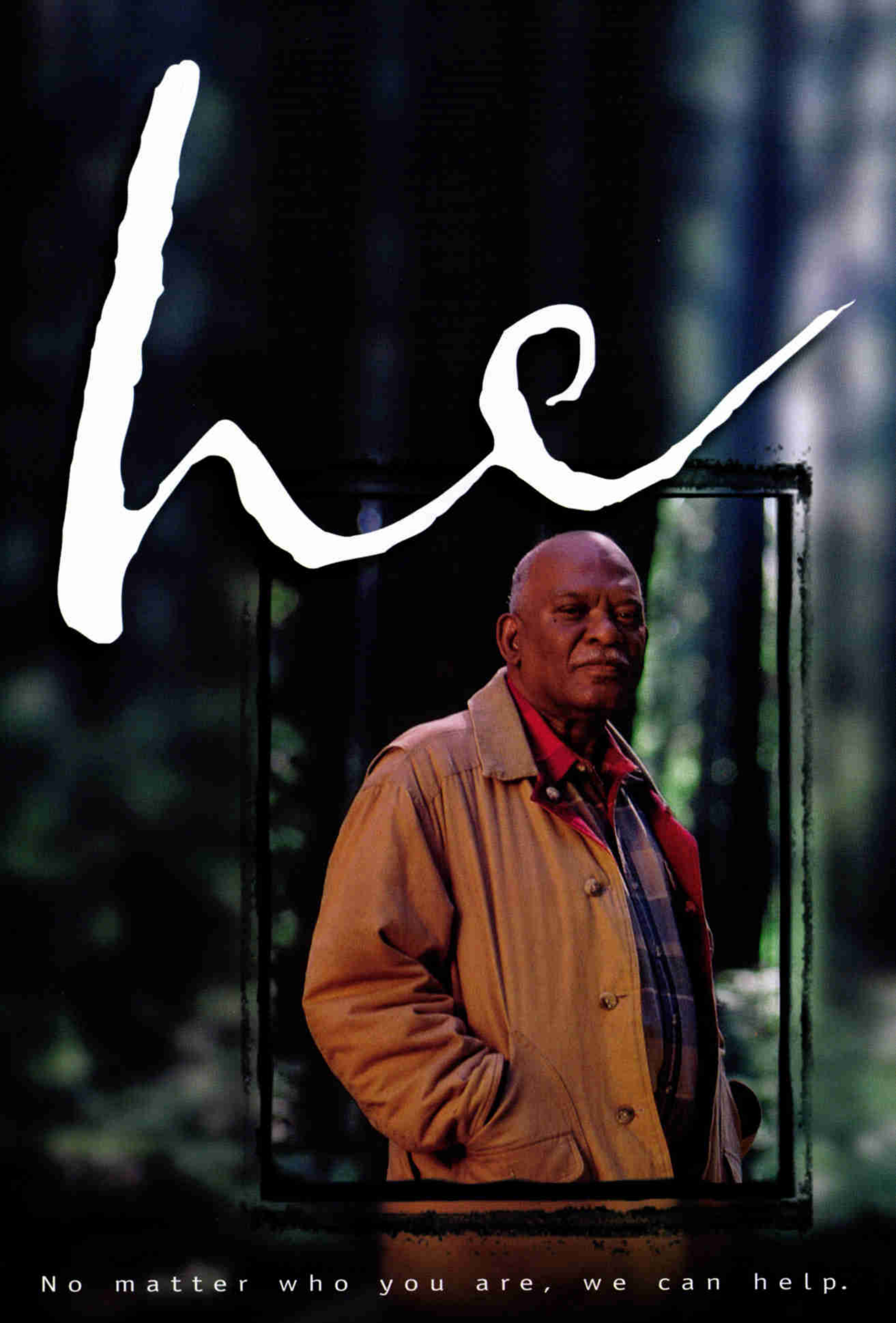
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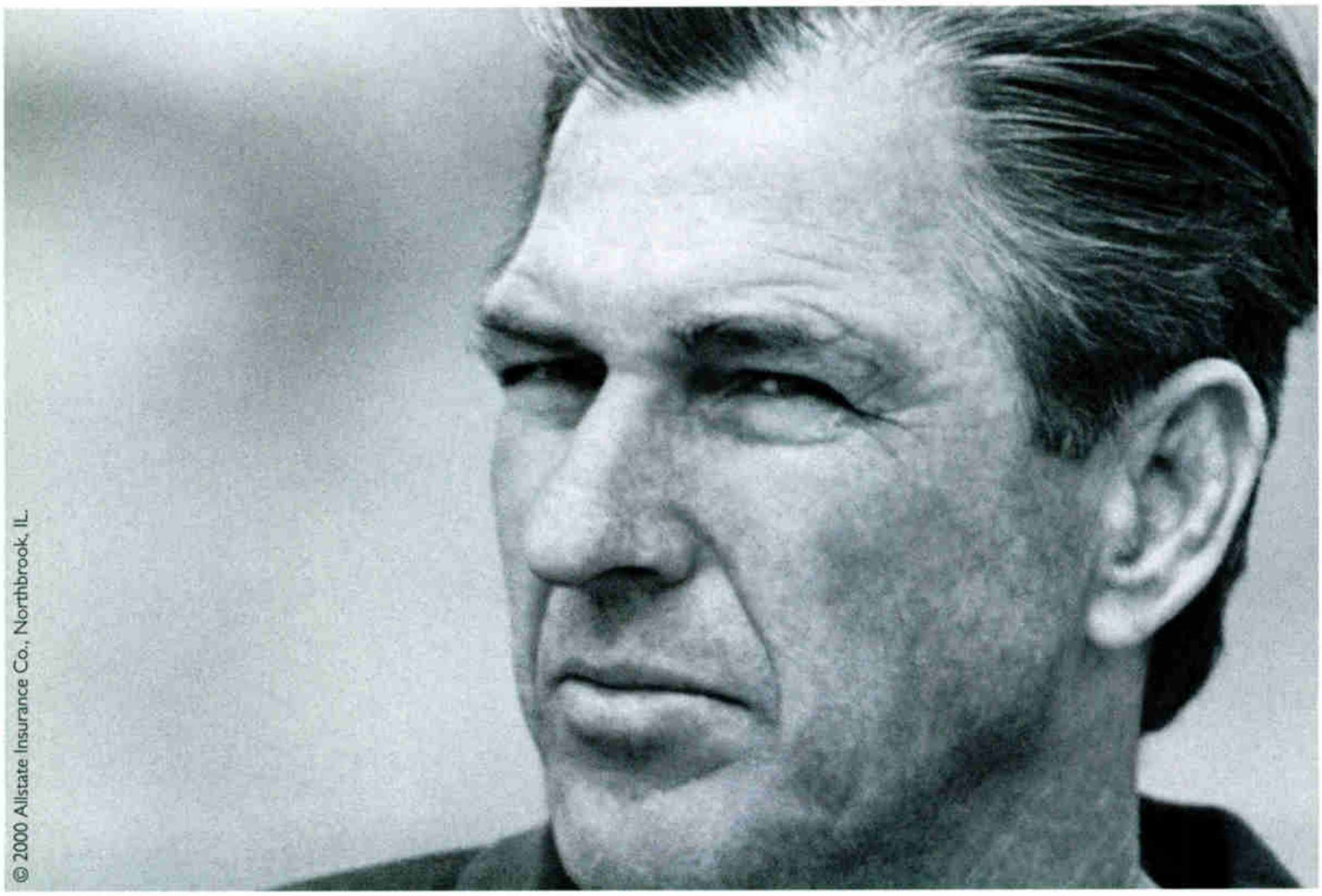
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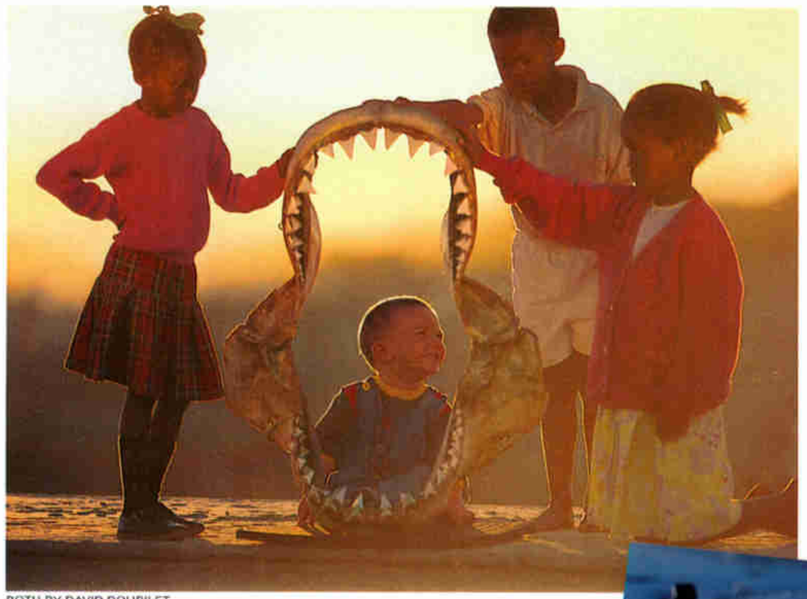
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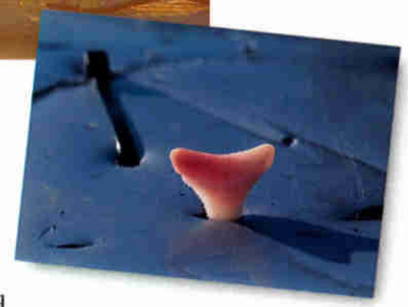
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BOTH BY DAVID DOUBILET

From the Editor

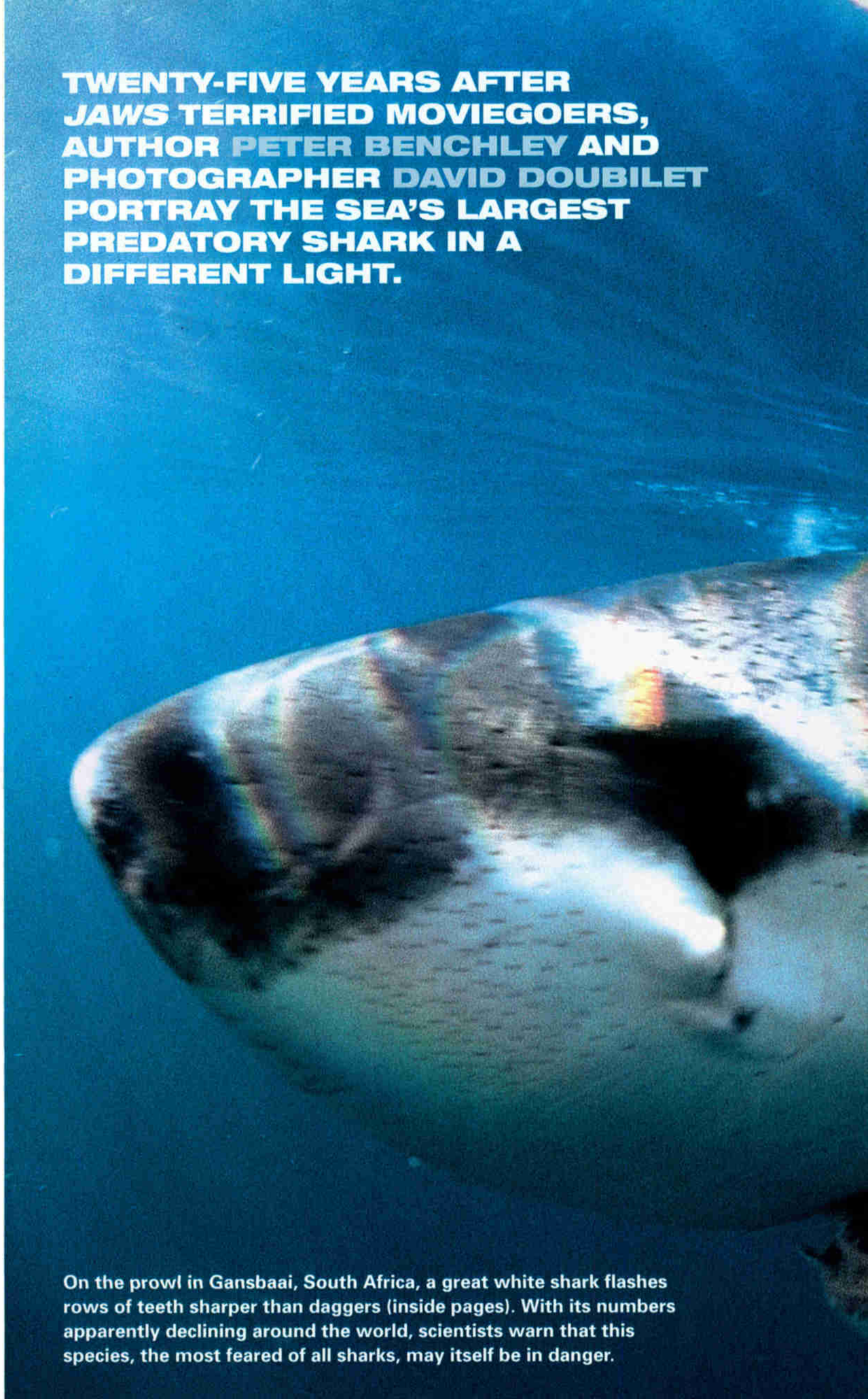
PETER BENCHLEY'S 1974 NOVEL *Jaws* and the box-office hit that followed confirmed that there are few words more terrifying than the cry of "Shark!" Today, perhaps, at the first rumble of a diesel engine on the surface the sharks should start scattering and scream "People!"

According to the World Wildlife Fund, the number of sharks off Hawaii that have been killed simply for their fins has skyrocketed 2,000 percent since 1991. Fishermen off Cape Cod, who for decades regarded the spiny dogfish as a worthless nuisance that preyed on traditional commercial stocks, have discovered these sharks' market value and reduced their populations to levels that threaten their survival. And sharks don't help their case with their fierce jaws (top) or when they leave a saw-blade tooth in a float used to support an underwater camera (above right).

In this month's article on great white sharks, Benchley helps de-demonize this magnificent fish. I doubt that any but the boldest divers will ever want to swim with the sharks. But at least we can stop making them the subjects of search-and-destroy missions.

Bill Allen

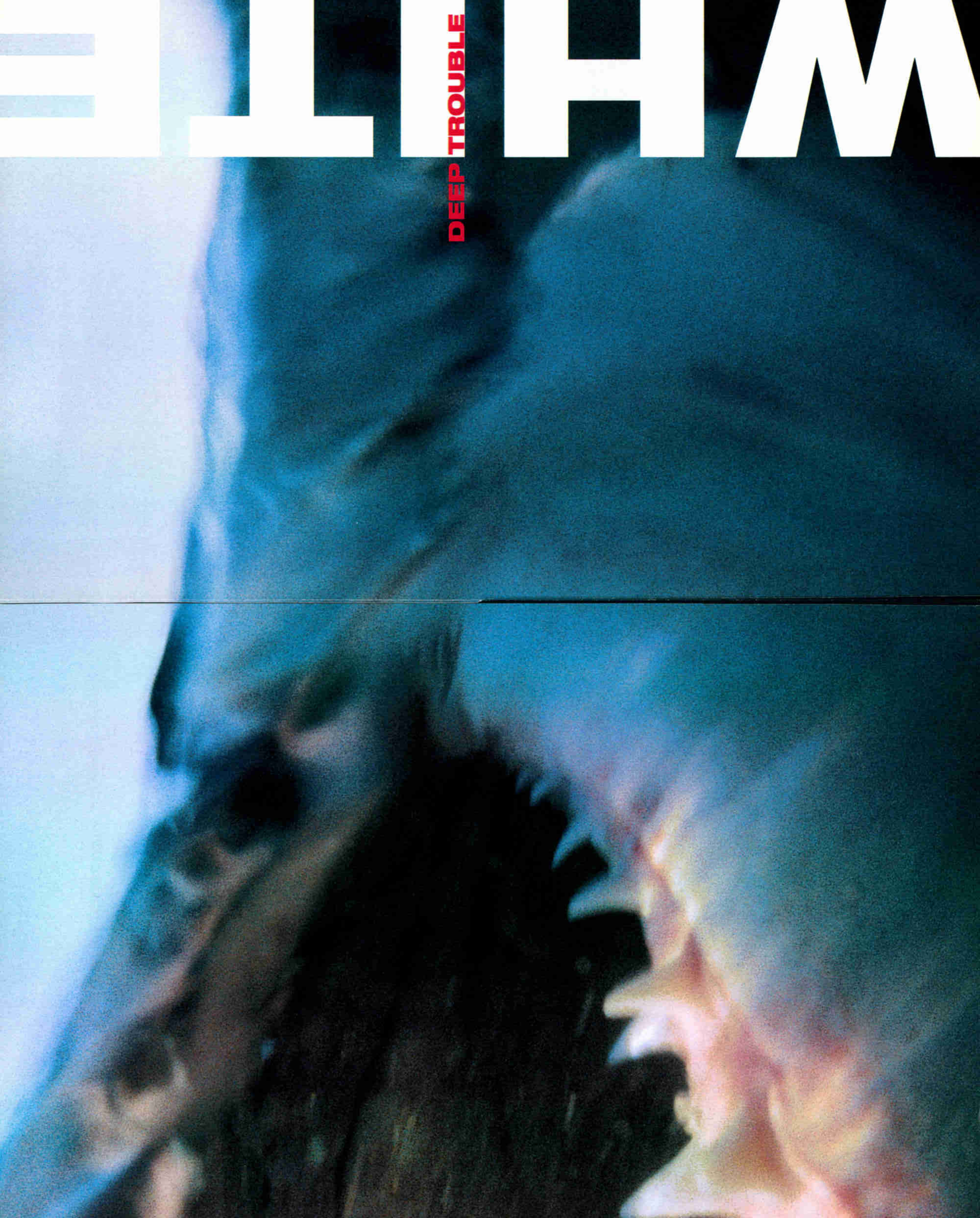
TWENTY-FIVE YEARS AFTER *JAWS* TERRIFIED MOVIEGOERS, AUTHOR PETER BENCHLEY AND PHOTOGRAPHER DAVID DOUBILET PORTRAY THE SEA'S LARGEST PREDATORY SHARK IN A DIFFERENT LIGHT.



On the prowl in Gansbaai, South Africa, a great white shark flashes rows of teeth sharper than daggers (inside pages). With its numbers apparently declining around the world, scientists warn that this species, the most feared of all sharks, may itself be in danger.

GREAT




DEEP TROUBLE

At the top of the undersea food chain, a 14-footer hunts near the surface in Gansbaai. The mysterious deep cloaks great whites, making research difficult, but we know they are not the ruthless hunters of humans they were once thought to be.



"Haai op die aas." Spoken casually, without a hint of alarm, the words meant nothing to me: a puff of incomprehensible Afrikaans. But the crew suddenly tensed, and their tenseness was contagious. Conversations stopped. Cameramen reached for their gear; the soundman rolled his tape. More than a dozen of us, crowded onto two tiny boats rafted together five miles off the tortuous shore of Gansbaai, South Africa, froze and watched the water.

Andre Hartman pointed aft to a spot a few yards behind the outboard motors. "*Haai op die aas,*" he said again, and this time his meaning was clear. "Shark on the bait."

The glass-calm sea was sliced by a steel gray dorsal fin. Behind it—at least six or seven feet behind—the blade of a crescent tail swept side to side, propelling the torpedo body toward us.

Slowly, smoothly, Andre drew in a rope whose end was knotted around and through the skull and entrails of a small cow shark. The big shark followed. No one asked what kind of shark it was; there was no question. Everything about it, from its size to its color to its shape to the cold ineluctability of its assault, broadcast its identity: Great White Shark.

I could see the body now, gray dappling brown as sunlight flooded the misty blue-green water, and I recalled words I hadn't thought of since I wrote them more than a quarter of a century ago: "The mouth was open just enough to permit a rush of water over the gills. There was little other motion: an occasional correction of the . . . course by the slight raising or lowering of a pectoral fin—as a bird changes direction by dipping one wing and lifting the other."

Andre lifted the bait aboard and dropped it in a box. Quickly he knelt on the wood square mounted between the two motors. Bracing himself with his left hand, he plunged his right into the water, just as the pointed snout and great conical head reached the first motor.

"For God's sake, Andre," I said, "what. . . ."

His hand grabbed the snout, moving it away from the shaft of the motor, guiding the head of the shark up as it rose out of the water.

There, in an instant, was the mouth, the most notorious mouth in nature, the upper jaw dropping into view, extending its rank of serrated triangular daggers, the lower jaw falling open, studded with the needle-sharp grabbing teeth that, more than a century ago, gave the animal its scientific moniker: *Carcharodon carcharias*, "ragged-toothed" one.

Andre's hand cupped the snout, almost caressing it, and as his arm straightened, the enormous head eased back and rose even farther into the air. And there it stayed, motionless, vertical, suspended—apparently—by some mystical connection with Andre.

No one spoke. No one breathed. The only sound was the motor drive on David Doubilet's camera as it captured frame after frame after frame of man mesmerizing monster.

The moment seemed endless. In fact, it lasted—what, two seconds? perhaps five?—until Andre pulled his hand back. For one more heartbeat the shark remained suspended, and then—easily, gracefully—it half-slid, half-fell backward, slipped beneath the surface, and, its massive white belly gleaming up at us, appeared to swoon down into the gloom.

Still nobody spoke. We gawked at each other.

At last Andre grinned and said, "The first time it was an accident. I was just trying to shoo a shark away from the motor. Sharks are drawn to motors by their electrical signals and have a habit of biting them to see if they're edible—that's how they decide what and what not to eat—and sometimes they'll knock out a bunch of their teeth." A former commercial fisherman and champion spearfisherman, Andre has been living side by side with great white sharks for years. "Anyway, my hand landed on its nose, and it sort of paused, so I kept it there, and when I did let go, the shark snapped and snapped, like it was searching for whatever it was that had hypnotized it."

PETER BENCHLEY's first novel, *Jaws,* was published in 1974. He co-wrote the screenplay for the movie, which was released a year later. Great white sharks have also been an integral part of DAVID DOUBILET's 40 years as an underwater photographer.



GARY BELL

Caught by accident on a line set for snapper, an 18-foot female—showing the white belly that gave the shark its name—draws a crowd in Adelaide, Australia. Great whites are now protected off Australia, the southern tip of Africa, the Maldives, and parts of the U.S.

David and I exchanged a glance. The shark's reaction struck us both as quite similar to the phenomenon scientists *call* tonic immobility. We had heard that other sharks, smaller sharks, can be made to pause in a kind of suspended animation when turned over on their backs. Had Andre's hand somehow had the same effect, perhaps by interrupting the flow of sensory signals that activate the shark's brain? Or perhaps Andre actually overstimulated the shark's sensory organs. No one knows. Maybe the shark simply grew confused by being unable to reach something with its jaws that it sensed was nearby.

What I do know is that neither David nor I had ever heard of, let alone seen, such behavior between a human being and the most feared of all the creatures in the sea.

By now, however, we were growing used to the unusual, for in nearly every encounter we had had with great whites over the past six months, from the stormy Southern Ocean off Australia to here on the southeastern tip of the African continent, the magnificent animals seemed intent on defying conventional wisdom and confounding the experts.

THE MORE WE LEARNED, the more we realized how little is really known about great whites. Despite vast leaps of knowledge since *Jaws* was published in 1974, no one—not scientists, fishermen, or divers—yet knows for certain such basic things as how big they can be (how long, how broad, how heavy), how many years they can live, how many of them exist, when and where they



mate, how many young they can carry, where they spend their time, and what, specifically, impels one great white shark to attack, kill, and consume a human being and another to bite and spit out the same hapless sort of victim.

I became convinced, too, that considering the knowledge accumulated about great whites in the past 25 years, I couldn't possibly write *Jaws* today . . . not in good conscience anyway.

Back then, it was generally accepted that great whites were anthropophagous (they ate people) by choice. Now we know that almost every attack on a human is an accident: The shark mistakes the human for its normal prey.

Back then, we thought that once a great white scented blood, it launched a feeding frenzy that inevitably led to death. Now we know that nearly three-quarters of all bite victims survive, perhaps because the shark recognizes that it has made a mistake and doesn't return for a second bite.

Back then, we believed that great whites attacked boats. Now we know that their sensory systems detect movement, sound, and electrical fields (such as those caused by metal and motors) in water, and when they approach a boat, they're merely coming to investigate. (Granted, investigation by a 3,000-pound animal can wreak havoc.)

Finally, back then, it was OK to demonize an animal, especially a shark, because man had done so since the beginning of time, and, besides, sharks appeared to be infinite in number.

No longer. Today we know that these most wonderful of natural-born killers, these exquisite creatures of evolution, are not only *not* villains, they are victims in danger of—if not extinction quite yet—serious, perhaps even catastrophic, decline. Much of the evidence is anecdotal: Fishermen and naturalists are seeing fewer great whites, and in most places those they are seeing are younger and smaller.

Scientists estimate that, worldwide, populations of some species of sharks have dropped by 80 percent. Though precise numbers of white sharks aren't known, there is a growing consensus that they are not reproducing at a rate sufficient to maintain the population. What *is* known now is that great white sharks—scarce by nature and growing scarcer thanks to contact with man—are, for all their grace and power and manifest menace, remarkably fragile.

Constantly on alert, an Australian sea lion would look like lunch to great whites, which seek out such pinnipeds but also eat dolphins, bony fish, whales, and other sharks.

EXACTLY HOW FRAGILE I discovered one day in the small South Australian resort town of Glenelg, home to the world's uniquely qualified white shark expert, Rodney Fox. In 1963 Rodney was attacked while spearfishing. He was snorkeling, with a dead fish dangling from a float nearby. The shark struck, retreated, then struck again. "I looked down," Rodney said when he told me the story years ago, "and saw that great big jaw rising at me through a cloud of my own blood, and I knew I was in trouble." Trouble, indeed. Only a series of amazingly lucky breaks—including the fact that the strands of his neoprene wet suit held his guts in—saved his life. He spent weeks in the hospital and months in recovery, sewn together, like a quilt, with 462 stitches.

Rodney went on to win the South Australian team spearfishing championships one more time, and ever since he has devoted his life to the study and protection of great white sharks. (As David Doubilet puts it, "The shark bit Rodney and then inhabited him.") He has never held a grudge against the shark that chewed him up ("He was only doing what sharks do"), and he offers advice to any diver who finds himself in the water with a great white: "Make sure he knows you've seen him. Great whites are ambushers, and once one knows he can't surprise you, he's probably not going to expend a lot of energy to get you. Move slowly to other divers or the boat."

Rodney was David's and my cicerone in our search for great whites, and he had heard that the South Australian Research and Development Institute (SARDI) had acquired a huge dead female. Before she underwent scientific dissection, her body was to be shown to the public as part of South Australia's ongoing effort to protect the sharks. (Though not officially designated as endangered worldwide, great white sharks are protected off South Africa and Namibia, Australia, the Maldives, and parts of the U.S.)

The day of the display dawned foul: wind, mist, and a pelting rain. Nevertheless 12,000 people stood in line—some for more than an



hour—for the privilege of walking by and seeing and smelling and touching the sad and sorry corpse of this single animal.

To be sure, she was impressive: about 18 feet long, 3,000 pounds, a robust, mature female with teeth two inches long and dark, impenetrable eyes. Child after child, adult after adult touched the shark not only with their fingertips but with their entire hands, as if to commune with the great creature. They were not afraid; they were awed, almost reverent.

For years after the movie version of *Jaws* exploded into the public consciousness, I was asked why I thought it had had such an impact. I had no answer beyond the obvious: People have always been terrified of sharks, of deep water, and of the unknown, and this story touched all those nerves.

Then, a few years ago, I came across some words by Harvard sociobiologist E. O. Wilson. "We're not just afraid of predators," he wrote, "we're transfixed by them, prone to weave stories and fables and chatter endlessly about them, because fascination creates preparedness, and preparedness, survival. In a deeply tribal sense, we love our monsters."

True enough. I, transfixed, had woven stories and fables. And here were these men, women, and children—soaking, cold, and tired—gathered in what was definitely a kind of love for this monster.

They all wanted to know what had killed her. What *could* kill her? Children especially wanted to know *why*, why would anyone kill such an animal?

The answer to what had killed the shark was depressingly banal. "A longline," said John Keesing, then SARDI's chief scientist. "A fisherman had set out a longline to catch snapper, and she happened upon it. She got hooked, and in trying to get away, she wrapped herself up in the rope. When it came taut, she couldn't move. She drowned." Like many sharks, she had to keep moving to flush oxygen-rich water over her gills.

Longlines are among the most insidious killers in the sea, for they kill indiscriminately, old or young, pregnant or not, endangered or not. In the open ocean some longlines stretch for 80 miles and contain thousands of hooks.

Unlike some fishermen, the man who caught this shark obeyed the law, notified the proper authorities, and even brought the body to shore. He had requested that he be given

THEY DELIVER A DEVASTATING BITE





In a life or death struggle, a South African fur seal (top) twists out of the water to escape a lunging great white at False Bay, South Africa. "These duels are like aerial dogfights except that only the heavy, slower jet is armed," explains Rocky Strong, a California-based researcher. "The little guy can only fly defensively." Nearby, a wounded fur seal (bottom) will likely be finished off soon.

the jaw. The government turned him down.

"We couldn't give it to him," John explained. "A jaw this size might bring $10,000 on the open market. If we let him keep it, suddenly we'd find a whole lot of white sharks being killed 'by accident.' "

And so, jaw and all, the shark was hauled off to the Bolivar maceration facility, next door to a sewage-treatment plant on the plains north of Adelaide, where a ton and a half of great white shark could be studied out of the public eye.

This was a rare boon for the scientists. One reason so little is known about great whites is that they are enormous, bulky, and hard to handle. And that's when they're dead. Studying a live great white shark up close and in detail is, for obvious reasons, practically impossible.

Barry Bruce, one of Australia's preeminent shark experts, had flown over from his base in Tasmania to oversee the dissection and study of the shark. He and his assistants got into blue jumpsuits, rubber boots, and gloves, and as Barry delicately—with a knife suitable for quartering an ox—sliced open the belly of the beast, I stood beside him and watched.

"We know a few things for certain," he said. "For example, we know that they're warm-bodied, like all the lamnid sharks. (Others in the Lamnidae family include shortfin and longfin mako sharks.) Their body temperature is sometimes ten to fifteen degrees [Celsius] warmer than the surrounding water, which makes them efficient predators in cool water. We know they're primarily coastal, so they have contact with humans, and sometimes they lose. Then again, they do venture into deep water. They've been found off Hawaii, in the Coral Sea, the Caribbean, and the Atlantic. But we don't know much about their travel and migration patterns."

In my experience the best way to find a great white shark is to go where they're not supposed to be. A ten-footer and I had a chance meeting underwater years ago in the Bahamas, where, at the time, great whites were unheard of. The shark was as shocked to see me as I was to see it. It stopped dead in the water, braking with its two pectoral fins, voided its bowels, and fled. (My reaction? Well . . . none of your business.)

I asked Barry if anyone had a reliable estimate of the number of great whites in the world, and he said flatly, "No. We don't even know how many there are around Australia. Not very many, though."

"A hundred?" I asked. "More? Less?"

He wouldn't bite. "Nobody knows."

Rodney chimed in. "I've heard people claim that 40 or 45 great whites are killed every year here in South Australia, by longlines, nets, and illegal fishing. No question, some people still do target them for the jaw or for what they call 'sport.' But to sustain a loss like that—45 individuals a year—I would think the population would have to be a couple of thousand. I find it hard to believe that there are that many great white sharks in South Australian waters."

Until recently sharks have had no constituency: That is, there has been no public outcry to Save the Sharks, as there has been for whales and dolphins. One problem, of course, is that unlike whales and dolphins, sharks aren't cute,

AND WAIT FOR THE PREY TO BLEED TO DEATH, THEN PARTAKE OF A LEISURELY MEAL.

they don't nurse their young, they don't appear to "talk" to one another, and consequently they're hard to anthropomorphize. More practically, unlike whales and dolphins, which are mammals, sharks don't breathe air, so they don't surface at regular intervals and thus are not easy to track and count.

Also, great white sharks do have a documented record of killing human beings. (Rarely though: only 74 times in the past hundred years, according to the International Shark Attack File.)

Nowadays more people are coming to respect and appreciate sharks for what they are: beautiful, graceful, efficient, and, above all, integral members of the ocean food chain. In large measure the change is due to television and the abundance of films documenting not only the glories of sharks but also the dangers to them from longlines, nets, and the odious practice of finning—slicing the fins off sharks to sell in Asian markets, then tossing the living animals overboard to die. Gradually governments and individuals are learning that while a dead shark may bring ten or twenty or even fifty dollars to a single *(Continued on page 24)*



Safe behind bars, documentary filmmaker Malcolm Ludgate reaches for his subject in Gansbaai. "If you avoid the bitey bits, you can pet some of them quite nicely," he says. "You wouldn't believe something that big could come in that close and be so quiet."



WATER ERUPTED. A GIGANTIC BODY BLASTED THROUGH THE SURFACE.

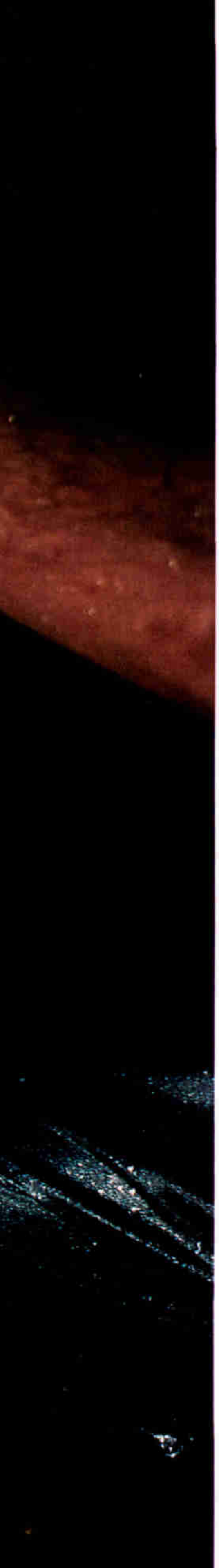


With a seldom-seen breaching maneuver, a great white ambushes a towed decoy near a fur seal colony in False Bay. Splashdown (right) smashes the decoy held in the shark's jaws. "Anything moving across the surface in this feeding area is likely to be hit," explains Rocky Strong, who says that motion and size are key factors in triggering an attack. "It's shoot first and ask questions later."









ANDRE'S HAND CUPPED THE SNOUT, ALMOST CARESSING IT.



"I'm not missing any fingers," says Andre Hartman, co-owner of a South African shark-diving operation, of this photo (left). "I've got two wrapped around its nose and the others in front." Such gentle touches on a sensitive area can make the animal rise open-jawed, swoon, and slip back into the water (above). Scientists don't know exactly why this happens, but it likely involves the electro-receptor pores that pepper the snout.

(Continued from page 15) fisherman, a live shark can be worth thousands of dollars more in tourist revenue to a community. Divers will fly halfway around the world to see white sharks.

Immodestly I claim some credit for the change in attitude, for while the *Jaws* phenomenon was blamed for distorting the public's view of sharks and causing sporadic outbreaks of macho mayhem, it also generated a fascination with and, over time, an affection for sharks that had not existed before. These days I receive more than a thousand letters a year from youngsters who were not alive when *Jaws* appeared, and all of them, without exception, want to know more about sharks in general and great whites in particular.

Great white sharks are among the true apex predators in the ocean. The largest predatory fish in the world, they have few natural enemies. And so, in balanced nature, there are not very many great whites, and the number grows or shrinks depending on availability of food. They breed late in life and pup relatively few. Again, nobody knows exactly how many, but seven or eight seems to be a safe average. The youngsters appear alive, four or five feet long, weighing 50 or 60 pounds, fully armed and ready to rumble. Still, many don't survive the first year because other sharks, including great whites, will eat them.

Of all the infuriating unknowns about great white sharks, none is more controversial than size. How big can they grow to be? Fishermen from Nova Scotia to South Australia, from Cape Town to Cape Cod claim to have encountered 25-footers, 30-footers, even 36-footers. (Usually the proof offered is that the beast was "bigger than the boat.") There have been reports of a 23-footer in the waters off Malta and a 21-foot, 7,000-pounder off Cuba, but none has held up under scrutiny. The largest generally accepted catch—made by lasso, of all things—was a shark 19.5 feet long. The largest great white shark ever caught on rod and reel weighed 2,664 pounds.

According to British biologist Ian Fergusson, chairman of the Shark Trust, no great white shark longer than 19.5 feet has ever been validated, and in an e-mail widely circulated last spring, he expressed irritation at "this stubborn reluctance by some elements of the media to accept the facts and even more of a reluctance to accept that a 16-foot, 4,500-pound white shark is BIG, very BIG, and should need no further exaggeration to impress even the most discerning of viewers when seen up close."

I can attest that underwater, cruising toward you out of the gloom with the serene confidence of the invincible, a 12-foot great white looks like a locomotive with malice in mind.

WHEN THE BELLY of the dead shark was open, Barry Bruce beamed. "Look at that liver," he exclaimed. "That's a 500-pound liver." The liver is an immense energy-storage facility, and I liked

FOR ALL THEIR GRACE AND POWER



Risky business: Diving for abalone in shark territory off southern Australia earns Damon Edmunds $385,000 (U.S.) for an 80-day season in which encounters with great whites are rare but unforgettable. Once, when he was diving with just an air hose, a 15-footer pinned him in a trench for three hours until a diver came to his rescue with a cage. "I was about at the end of my tether," he says.

Rodney's clear and simple description of how it governs the shark's feeding habits. "If a shark has eaten a whole seal or sea lion," he said, "it might not have to eat for a month. But the smell of chum or bait or blood in the water will stimulate the feeding impulse, and it may decide to top off its tank of energy."

Barry removed several vertebrae from the shark's cartilaginous spine (like all sharks, great whites have no true bones). He wiped one clean and held it up. "See the rings? Those are growth rings that we use to age sharks, just like rings in the trunk of a tree. In white sharks we are only just starting to understand which ones to count to give their age in years. We think female white sharks start breeding when they're about 12 to 14 years old."

To reach the heart, Barry had to actually climb *inside* the body cavity of the shark, and the image proved irresistible to everyone with a camera, myself included.

Pores on the shark's snout were oozing what looked like jelly, and I asked Barry what it was. "Those are the famous ampullae," he said, referring to the ampullae of Lorenzini, named after the Italian scientist who first described them in the 1670s. By detecting bioelectric impulses in the water, these jelly-filled canals are among the most important of the shark's sensory organs.

Much of the shark was reduced to reeking flesh and bloody cartilage, but the head remained intact, staring implacably, a constant reminder of what it once had been.

I needed no reminder, for still fresh in my mind were images I had seen the day before, postmortem photographs of a young man killed by a great white shark the previous June, close to shore, in a little bay on an island in the Neptunes, where he and a pal had been snorkeling for abalone. The shark had bitten him only once, severing arteries in a leg and an arm, and the man had bled to death.

"Obviously the shark didn't want to eat him," the man who had the pictures told me. "It bit down, had a taste, and let him go. It knew this wasn't its normal prey."

This episode seems to reinforce a hypothesis proposed by A. Peter Klimley, a shark expert at the Bodega Marine Laboratory in Bodega Bay, California. He holds that great white sharks have an ability to assess the energy value of prey in the microsecond of a first bite. If the prey is perceived as not containing enough energy value to justify the energy expended in a full-scale attack, the shark releases it; if, however, the prey is perceived as being rich in fat (a seal, say, or a sea lion), the shark will pursue the attack. It will deliver a first, devastating bite and wait for the prey to bleed to death, then partake of a leisurely meal.

"If they ingest something that's not energetically profitable," Klimley says, "they're stuck with that for a few days. Fat has twice the energy value of muscle."

Rodney, for one, believes wholeheartedly in the idea. "The shark spat *me* out, didn't he?" he says. "I was too bony for him."

Over the past few decades the number of great white shark attacks worldwide has increased steadily, according to the International Shark Attack File. This is at least partly because more people (divers, surfers, swimmers) are using the water.

Fatal attacks, however, have decreased. Forty years ago more than half of all attack victims died; today more than four out of five victims survive. Improvements in communications and emergency medical care have, of course, saved many lives, but Peter Klimley believes that in several cases the sharks have simply changed their minds. "Can you imagine?" he said. "These sharks are seizing people and holding them to make this decision. They strike and hold and release."

At the moment science accepts about 400 species of sharks, but the number changes as new species are discovered. Of all known species, only four attack human beings with any frequency: bull sharks, tiger sharks, oceanic whitetips, and great whites.

The old adage is true: A swimmer has a better chance of being struck by lightning than killed by a shark. And around the world many, many more people die every year from bee stings, snakebites, falling off ladders, or drowning in bathtubs than from shark attack . . . none of which, to be sure, detracts

AND MANIFEST MENACE, GREAT WHITE SHARKS ARE REMARKABLY FRAGILE.

from the ghastly, visceral horror of being eaten by a huge fish, but all of which should give some comfort to the recreational swimmer.

In Australia, between 1876 and 1999, 52 attacks by great whites were recorded, and of them 27 were fatal. In the Mediterranean Sea since 1900 there have been 23 reliably recorded encounters with great whites, including one in 1909 in which the remains of two adults and a child were found inside a single 15-foot-long female shark caught off Augusta, Sicily.

Curiously, there has been relatively little progress over the past 50 years in the development of shark repellents. Dyes have been tried; so have chemicals and bubble curtains. The current state of the art uses electricity. So far, though, nothing has been proved to discourage a hungry great white in full attack.

WE WENT to South Africa in the southern winter because of a phenomenon long known to locals but only recently deemed significant by researchers: In wintertime great whites gather in large numbers in a few bays in a little pocket between the Cape of Good Hope and Danger Point.

"The warm Agulhas Current sweeps down the east coast of Africa, out of the Indian Ocean," Andre Hartman explained, "and meets the cold Benguela Current that flows up the west coast. Where the currents mix, there's a temperate zone in False Bay, Gansbaai, and Kleinbaai, and sharks gather there in the winter. The temperature seems to suit them."

So does the abundance of yearling South African fur seals, which swarm over rocky islands in the bays and provide a smorgasbord for the sharks.

We drove from Cape Town to False Bay, so named perhaps because early explorers who rounded the Cape of Good Hope thought that their next landfall would be India—until they bumped into the eastern shore of the bay, 20 miles away. Here Robert Lawrence and Chris Fallows run a modest cage-diving operation. For roughly a hundred dollars the young men will take visitors and scientists a few miles offshore and show them great white sharks from their choice of shelters: a small boat or an even smaller cage. They promised to show us behavior that, till now, we all had believed was the stuff of extreme rarity, if not outright legend.

We crowded into two boats and left the dock as day was breaking. It took us only 30 minutes to approach Seal Island, and we smelled it long before we saw it. Some 84,000 fur seals make their home here, and they covered every inch of the barren rock, barking, lounging, squabbling, and sliding clumsily into the water, where they metamorphosed into creatures of sleek and sinuous beauty.

Behind the boat we trolled a plastic seal with a videotape camera mounted in its belly, pointing downward.

We settled down to wait, confident that it would be hours before we. . . .

The water erupted. A gigantic body blasted

"GREAT WHITES ARE AMBUSHERS,



Within striking distance of a shark lured by chum in Gansbaai, Andre Hartman delivers deterring taps with a speargun. "They're interested—but not really to eat me, just to see who I am," he says. "They think I'm feeding off the same thing they're smelling." Other divers do not share his confidence: In waters where its prey swim, they say, a great white may easily attack a human.

through the surface—white beneath, gunmetal blue above, glinting in the dawn sunlight—with the seal decoy in its jaws. The shark flipped completely over, hit the water with a tremendous splash, and disappeared.

Before anyone could speak, it happened again: a rush from the dark, an explosion at the surface, a balletic somersault, a splash.

"The violence!" Rodney said. "My lord, the violence! We know they attack from below. We know they eat seals. But the violence!" He paused, then said, "If I'd seen this behavior soon after my attack, I tell you, today I'd be a first-class *golfer.*"

It was the breaching that none of us had ever seen, the sheer power of the attack that heaved the huge body out of the water. I turned to Rob and asked, "Does this happen often?"

"Every day," he said. "Early in the day and late, morning and evening, when the seals leave the island to feed and when they come back. There's. . . ."

Another shark soared into the air. This time the seal in its jaws was not one of our decoys.

"As I was saying," Rob resumed with a wan smile, "there's what you could call a ring of peril about a hundred yards wide around the island. The sharks patrol it. The seals know it."

Indeed, as we watched, half a dozen seals slid off the rock and gathered at the surf line. All at once they disappeared. A few moments later they reappeared, but not together, each on its own a couple of hundred yards out in the water . . . outside the ring, I supposed.

No one knew why these great white sharks breached during the hunt, while the sharks Rodney had studied in Australia for 35 years didn't. I could not recall hearing about populations of white sharks that breached so regularly and ferociously, nor could Rocky Strong, a young doctoral candidate who had joined us a few days earlier to work on a National Geographic Society grant to study white shark behavior.

Rocky did, however, find the breaching to be a possible cause for concern. "Each unsuccessful breach consumes a tremendous amount of energy," he said. "If there's a lot of debris on the surface, these guys could conceivably wipe themselves out chasing shadows."

Two hours farther up the coast, in Gansbaai, shark-watching and cage-diving operations contribute mightily to the economy. Like False Bay, Gansbaai has a large seal colony close to shore, on Geyser Island, and in a channel around the island that has come to be known as Shark Alley. Here, apparently because the water is slightly shallower (not as much runway room), the sharks don't usually breach; instead, they seem to swarm.

J. P. Botha, co-owner of Marine Dynamics, the company that took us out, told me that most of the operators are former commercial fishermen or abalone divers.

"We're no different from the rest of the world," he said. "Too many people, too few fish. Catches are down everywhere. Great white shark tourism—ecotourism, if you will—is a better business than fishing."

Ecotourism is also joining the vanguard of research. More and more these days it is

AND ONCE ONE KNOWS HE CAN'T SURPRISE YOU, HE'S PROBABLY NOT GOING TO EXPEND A LOT OF ENERGY TO GET YOU."

the naturalists and field operators, guides and dive masters who are *contributing* to the accumulation of practical knowledge about great whites. To cite just one example: Until recently scientists thought that the scars that mar nearly every mature shark were acquired either from prey that fought back or from ritual biting by prospective mates. Now there is eyewitness testimony of aggressive social interaction between sharks and also of spectacular threat displays that take the place of major—potentially fatal—encounters with other white sharks.

So we are learning—bit by bit, anecdote by anecdote—more and more about these magnificent predators. We must hope that we're learning enough to save them before, through ignorance and inadvertence, we destroy them.

Great white sharks have survived, virtually unchanged, for millions of years. They are as highly evolved, as perfectly in tune with their environment as any living thing on the planet. For them to be driven to extinction by man, a relative newcomer, would be more than an ecological tragedy; it would be a moral travesty.

Slashing jaws are the stuff of nightmares. In reality great whites usually back off after biting humans, perhaps sensing that we're not their normal prey. Magnificent predators, they play a role in the ocean's balance of life that we are only beginning to understand. □

Want to know more about another species of shark? Dive into Australian waters with a National Geographic TV crew at *www.nationalgeographic.com/tigersharks.*



Exercising a right not always granted in the Arab world, women queue up at a polling place in Sanaa, Yemen's capital, to cast their ballots in a parliamentary election. Marrying modern ideas to traditions hard as stone, Yemen survived civil war and economic turmoil and has emerged with a new sense of purpose.

Yemen

UNITED

By ANDREW COCKBURN
Photographs by STEVE McCURRY

Tough country dominates Yemen and keeps villages like Safan in a state of perpetual self-reliance.



With few natural resources, Yemen is nonetheless rich in culture, history, and scenery.

Treating aches the traditional way, a healer in Bayt al Faqih makes a series of incisions, then places



a heated horn over each to create suction. Finally, through a tiny hole, he draws out blood.

JUST OUTSIDE the ancient walled city of Sadah, in the far north of Yemen, Sheikh Othman Hussein al-Fayed is having a typically busy day. Since early morning the courtyard in front of his fortified mansion has been filling with members of his tribe, the Abdein, here to seek his counsel on disputes ranging from marital spats to murder.

Elected sheikh by the tribal elders only a year before, the handsome, 28-year-old Othman has gained high repute for the fairness and rapidity of his judgments, so much so that among the throng are members of other tribes, drawn by his burgeoning reputation. As the morning wears on, the petitioners, a few dozen at a time, check their automatic rifles at the front door and enter a comfortable, cushion-strewn holding room to wait their turn.

Upstairs in the mansion, under the chandeliers and the pastel pink stucco work on the ceiling of the long, whitewashed hearing room, Othman is considering the tricky question of one Bashir, a tribesman who a few months earlier killed a man while attempting to collect a debt. Arrested by the police, Bashir escaped from prison and raced to seek asylum at the sheikh's house, slaughtering a number of sheep and oxen on the doorstep and placing his Kalashnikov assault rifle in the blood, a traditional invocation of sanctuary. Othman escorted him back to jail, making it clear to the police that Bashir was now his prisoner to dispose of as he wished.

"It's a difficult case," explains the sheikh. "A lot depends on whether this money really was owed. When Bashir went to collect the debt, the man's family fired in the air to drive him off. He fired back and killed one of them. Now the rest of the family are demanding the death penalty."

As the headmaster of the local school, who doubles as court secretary, kneels at the sheikh's feet to record the deliberations, Othman confides that he will leave the killer in jail for another year or so until the victim's family has calmed down and lost some of their thirst for revenge. "Then I can negotiate a deal on the blood money, Bashir will go free, and everyone will be satisfied."

"Suppose," I ask, "the government was to insist on applying the law and punishing the man for murder?"

The sheikh's uncle, father-in-law, and chief bodyguard gaze at me in astonishment. "But he is under the sheikh's protection! If they tried to do that, it would be an insult. The entire tribe would take action against the government."

Elsewhere in the Middle East powerful police states rigorously enforce the stern authority of central governments and ruling families. In Yemen, home to 17 million people, 50 million guns, and a tradition of prickly independence, they do things differently. This is a country where passengers arriving at Sanaa International Airport are met by friends inside the customs area and where the government habitually switches off the cell phone system to prevent its use by restive tribes for battlefield communications. Little wonder that there is a free market in justice.

Tucked away at the bottom of the Arabian Peninsula, south of Saudi Arabia and west of Oman, Yemen has largely escaped the outside attention directed at other Middle Eastern states that are richer in oil or periodically involved in regional wars. "Yemen is 16th-century Europe," said the Dutch ambassador, proffering a can of Grolsch beer, a welcome relief in this Muslim country where alcohol-free beer is king. We were sitting on the roof of his residence in Sanaa as a huge pale moon rose from behind the mountains that circle the city. "You have dukes and counts and wars, blood feuds and ghosts."

The ghost reference arose in connection

ANDREW COCKBURN has covered the Middle East for many years. His most recent book is *Out of the Ashes: The Resurrection of Saddam Hussein.* Frequent contributor STEVE MCCURRY photographed "Kashmir: Trapped in Conflict" for the September 1999 issue.

with a widely circulated story that a modern apartment building on the road from the airport could not be rented because it had been taken over by jinn—spirits that Yemenis consider a third group of rational beings, along with men and angels.

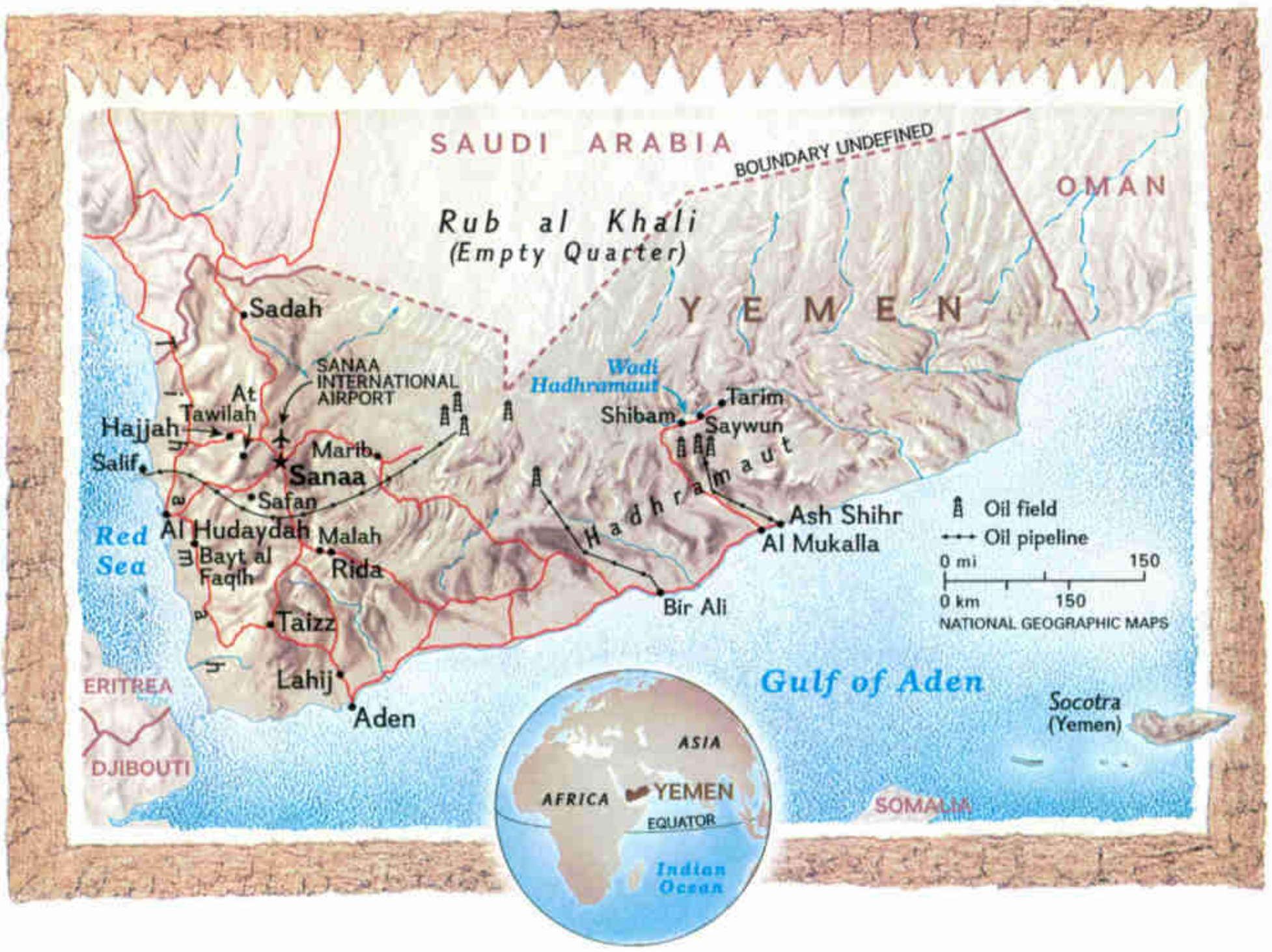
THOUGH YEMENIS are overwhelmingly Muslim and Arab, the dark faces and low, thatched houses of the searingly hot western coastal plain, the Tihamah, show closer connections with Africa, a few miles away across the Red Sea. Just behind the Tihamah rise the highlands, the heart of tribal Yemen. They extend all the way from the Saudi border in the north down to the Gulf of Aden washing Yemen's south coast. This is a starkly beautiful region of rugged peaks and narrow green valleys. Graceful castles and villages built of stone crown peaks and promontories fringed with terraces, testimony to the farmers' unending efforts to contain and channel the precious seasonal downpours. Sanaa, Yemen's capital, sits on a small plain in the center of these mountains. After a tenfold increase in population in the past 30 years, the city laps at the slopes of the stony mountains that surround it.

Southward, the road from Sanaa leads through mountain passes toward the ocean and the great natural harbor of Aden. To the east the road emerges from the highlands onto a high desert steppe that thereafter stretches across Yemen and into Oman. On the northern side this desert slopes gently down across the undefined (and much disputed) border and



On medieval streets in Sanaa a blacksmith works as neighbors pass the time by chewing the leaves of the qat *plant, which contain a mild stimulant. The discarded tougher leaves litter Yemen every afternoon. To boost productivity, government employees are now forbidden to chew during working hours.*

Ancestral homeland to the far-flung tribes of southern Arabia, Yemen thrived in ancient times as a center of the caravan trade, which passed through Wadi Hadhramaut and the town of Shibam (right), where mud-brick skyscrapers are coated with gypsum to repel rain. Two Yemens existed before a rocky political unification in 1990. South Yemen, under British rule until 1967, had modeled itself after Marxist states, while North Yemen, once part of the Ottoman Empire, maintained a market economy.



Yemenis have been wandering ever since the

merges with the trackless desert of Saudi Arabia. Far to the southeast a deep canyon carpeted with green oases, the Wadi Hadhramaut, cuts across the desert floor in a grand sweep carved by ancient rivers. Like the villages of the highlands, the towns on the floor of the wadi appear part of a different, isolated world.

But appearances are misleading. Yemenis have been wandering far afield ever since the Queen of Sheba set off to visit King Solomon in the tenth century B.C.; Yemeni armies were in the forefront of the initial Arab conquests—one of them briefly occupied Bordeaux, France. Yemen's current national hero is world featherweight boxing champion "Prince" Naseem Hamed, born and raised in Sheffield, England, from a family that emigrated from the highland village of Malah a generation ago. In the towns of the Hadhramaut I saw faces that would seem more at home on the streets of Jakarta or Kuala Lumpur or Manila. These people are descendants of the Hadhrami diaspora, traders who climbed the vertical walls of the canyon and made their way over the high, rocky desert to the sea. From there they ranged the Indian Ocean and beyond before returning with foreign wives to settle down amid the palm trees of the wadi.

Divided by nature into three distinct geographical regions—coastal plains, highlands, and desert—Yemen has for much of its long history been no less divided politically by the shifting fortunes of its fiercely independent inhabitants. Kingdoms and empires have risen and fallen here for more than 3,000 years. The Republic of Yemen itself, however, is a young country, founded in May 1990, when the Yemen Arab Republic that occupied the



Queen of Sheba set off to visit King Solomon.

mountains and the western coast merged with the People's Democratic Republic of Yemen (the Arab world's first and only communist state), which had controlled, from Aden, the south and east of the country since the expulsion of British colonial rulers in 1967. The unified republic, dominated by northerners, adopted a democratic constitution with an elected parliament and a (comparatively) free press—not an entirely welcome innovation in the eyes of its neighbors.

Two and a half months after unification Saddam Hussein invaded Kuwait. The Saudi government, angered at Yemen's failure to join the anti-Iraqi coalition and dismayed, perhaps, at the sudden unity of its southern neighbors, exacted a summary revenge by expelling as many as a million Yemeni residents. The sudden return of these émigrés, some of whom had been gone for decades, brought Yemen to the brink of total economic and social disaster. But the young state survived, partly because so many of the impoverished returnees found a ready-made support system in their tribes.

IN THE SANAA MILITARY MUSEUM, next to an enormous bullet-riddled 1950s Cadillac (a memento of an assassination attempt on a former president), lies a section of a Scud missile, one of several launched at Sanaa during the 1994 Yemeni civil war ignited by former leaders of the south, with Saudi encouragement and assistance, in an effort to regain their independence.

One consequence of the short but bitter war was a flood of ordnance to augment the already well-stocked armories of domestic consumers. The extensive area devoted to weapons in the

A boy in Hajjah becomes a little man to attend a wedding, donning gear worn by many highland males—a head covering, a dagger, and a Kalashnikov rifle. But in every community from Sanaa (below) to the smallest village, women rule the home, where generations often live under one roof.



Suq al-Talh, a huge weekly market outside Sadah, features an astonishing array of firepower ranging from the popular Kalashnikov (gleaming nickel-plated versions are advertised as "Michael Jacksons") to the 19th-century, single-shot German Mauser. The cacophony of merchants touting their lethal wares and arguing over prices is punctuated by the rattle of automatic fire as shoppers squeeze off a few test rounds before closing their deals. One merchant, Abdullah al-Awsa, has decorated the front of his stall with a high-level endorsement: "The Prophet, God's Blessings on him, said 'Teach your children to swim, to shoot, and to ride.'" The Prophet likely had bows and arrows in mind; it is hard to conceive what he would have thought about the shoulder-fired antiaircraft missile and launcher I was offered for only $700 three stalls down or the hand grenades retailing for the equivalent of $3.20 apiece.

The net effect makes Yemenis appear to be a very violent people. But even at such bargain prices there were few takers for the grenades. "There's no demand," said Faisel, another gun dealer, busily sticking "Made in USA" labels on his stock of Brazilian pistols to impress credulous customers from across the Saudi border. "The tribesmen don't want them." A customer shopping for ammunition at Faisel's stall supplied an explanation: "Grenades are just for killing people," he declared dismissively. Hence the lack of customer interest.

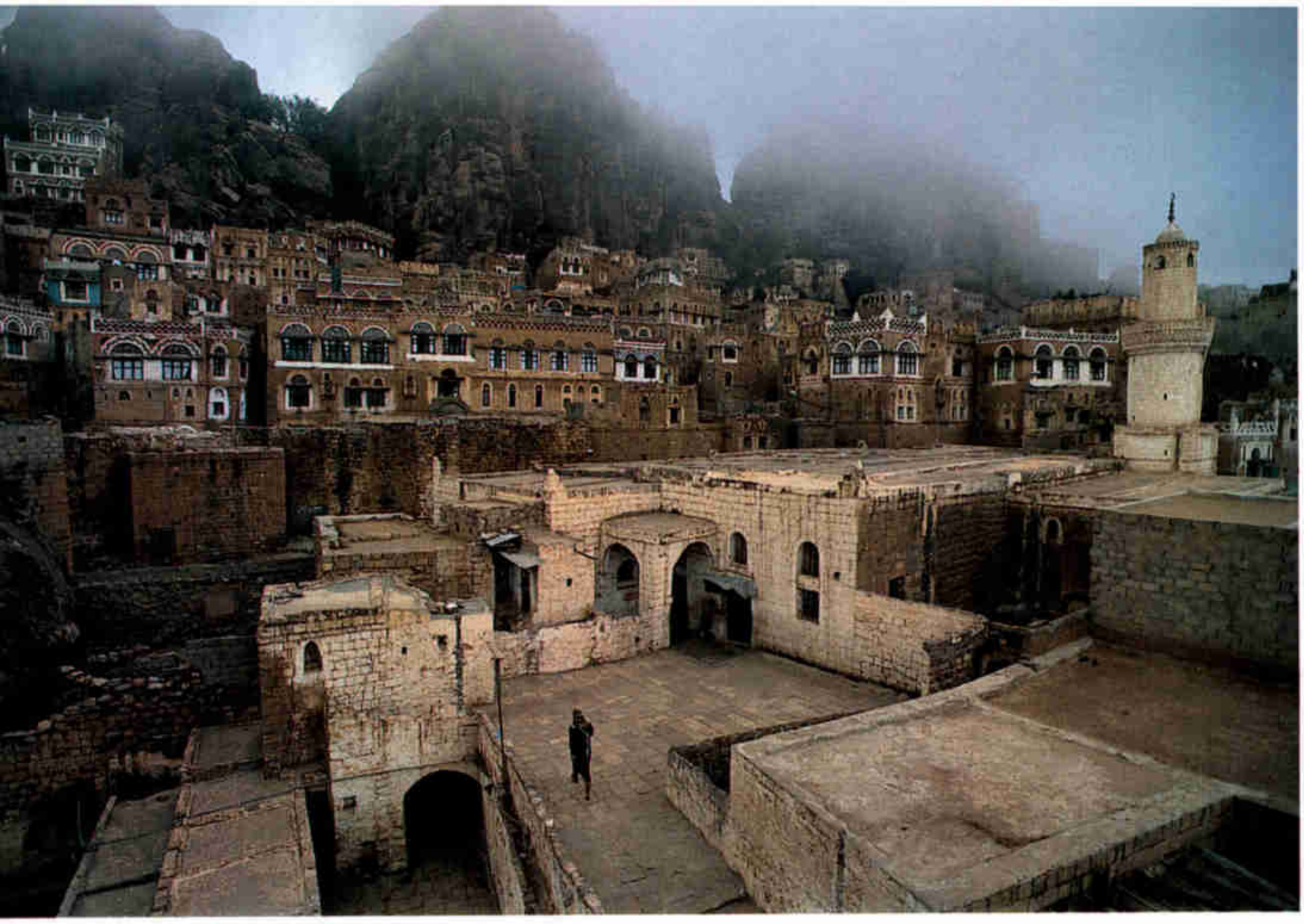
Guns on the other hand, usually Kalashnikovs, are as much part of the dress code for the highland male as his checkered headcloth, *jambiya* dagger, and ankle-length shirt or wraparound *futah* skirt. Guns are often used in anger but with less lethal effect than might be imagined. While I was in Sanaa, a property dispute close to the outskirts on Haddah Road led to a four-hour firefight. Hundreds of automatic rounds were fired at close range—without anyone suffering so much as a scratch. Honor satisfied, the parties submitted their dispute to arbitration.

The traditional laissez-faire attitude toward tribal contentiousness and customs such as the kidnapping of foreigners as a means of pressuring the central government suffered a rude shock in December 1998. During a shoot-out between their captors and the military, four

Drifting for hours on a cheekful of bliss, guests at a wedding in Sanaa chew the qat supplied to them

by their host. A mainstay of Yemen's domestic economy, qat is banned in other Arab countries.

Character etched in every detail, Yemen shows its ancient face in the mountain village of At Tawilah (below), where the simplicity of the mosque stands in contrast to the colors and intricate designs of traditional Yemeni architecture. In a shop in Sanaa, artisans craft ornamental daggers. Though almost never used as a weapon, the dagger, called a jambiya, *is an important symbol of manhood, even in the capital. "It's like the suit and tie of Yemen," says a diplomat from Lahij. "Don't leave home without it."*





In Yemen, home to a tradition of prickly

foreign tourists were killed. Yemenis, appalled by the carnage, were quick to explain that the kidnappers were a fanatical Islamic group directed from abroad, not at all representative of traditionally hospitable native kidnappers, who almost always release their captives unharmed. "If you get kidnapped," said a friend as I set off on a trip through a fractious tribal area, "the worst that will happen will be that they'll feed you boiled mutton for breakfast, lunch, and dinner, and you'll come home with a stomachache. But," he hastened to reassure me, "they will give you plenty of *qat*."

It is hard for outsiders to understand how an entire culture can be so fixated on chewing the leaves of a plant, even though it does induce a pleasantly uplifted mood. (A study sponsored by the U.S. National Institute of Drug Abuse found few signs that qat produces any serious physical or psychological side effects.) By unofficial estimates qat accounts for 30 percent of the domestic economy as an ever growing carpet of thirsty plants—Yemen is running out of water, partly thanks to qat farming—spreads across the scarce farmland. Up to 80 percent of the adult population uses qat, and much of the daily rhythm of life in Yemen revolves around the "chew" and its attendant rituals.

"Mid-morning, all my friends are on the phone discussing where to meet for the chew," explained a Sanaani businessman. "Then they have to decide where to meet for lunch beforehand—that's very important. Then they go buy their qat, with a lot of one-upmanship about who is the best judge of quality and who can drive good bargains with the dealers. Then they go chew *all afternoon before finally* heading home to their wives, who have been



independence, they do things differently.

having their own chew." Humbler folk may spend half their income on qat.

Popular faith in the beneficent qualities of qat is boundless. "When I chew, I am able to speak English, but I haven't chewed yet today," a dealer shouted to me in Arabic in Sanaa's huge Hassaba qat market.

"If I chew, will my Arabic become fluent?" I asked.

"My friend, if you chew my qat, you will sing in Arabic like a nightingale," he bellowed. His wooden stall carried an encouraging slogan: "Chew and relax. Success will come to you."

I eventually developed the ability to appreciate high-quality qat, such as the very expensive varieties sold at the Kuwait market on Agriculture Street in Sanaa. This emporium, where a bundle sufficient for an afternoon's enjoyment can cost as much as $40 or $50, is exclusively patronized by the rich and therefore is known to the congenitally irreverent general populace as the *suq al-waratha wa al-saraq*—loosely translated as the "market of trust-fund babies and thieves." An army chauffeur standing outside the market by the line of military staff cars, BMWs, and "Monicas" (as Yemenis, inspired by its curvaceous lines, have dubbed the Toyota Land Cruiser) cheerfully agreed that "they are all thieves here."

ONLY THE HADHRAMAUT, too low-lying and hot for qat cultivation, so far seems immune to the habit. "We do not chew," a supercilious Hadhrami informed me. "Only sheep chew."

Life in this region appears to move at a slower pace. Sanaanis consider it stultifying, but there is an atmosphere here of timeless



Cradling his share (left), a fisherman in Al Hudaydah heads home from the Red Sea, Yemen's best fishing ground. Visitors to the Gulf of Aden's moribund port of Al Mukalla echo the view of British writer Freya Stark in 1936: "magnificent from the sea, but rather dilapidated at close quarters."



serenity—nowhere more striking than in the town of Shibam, where the slim, towering, mud-brick high-rises stand in compact isolation in the middle of the wadi.

Late in the afternoon, flocks of tourists laden with cameras perch on a bluff opposite the town to capture on film the magic moment when the setting sun turns the town to gold. Their shots are marred, however, because the house in their immediate foreground has collapsed in an untidy heap of mud, like a sand castle overcome by the tide. "The family that owned it went off to Saudi Arabia eight years ago and left a tap dripping," said a local resident. "The whole house melted."

Reflecting on this, the ultimate in dripping-tap horror stories, I climbed seven stories up one day to a roof on the edge of Shibam to watch the sun sink over the walls of the canyon. The noise of Shibamis talking and laughing in the cool of the evening down below receded to a distant murmur, as did the shouts from energetic soccer players who had marked out an impromptu field in the soft sand that borders the town. "They are all unemployed, back from the Persian Gulf because there is no work there this year," remarked Abdullah, my guide, who was sharing my vigil and whose own last employment, two years before, had been on an archaeological dig at the site of an ancient temple a few miles away. "It's the times we live in."

As we gazed over the town, I had to be careful not to peer down into the windows of nearby houses for fear that I might intrude on the sequestered privacy of local women who, like Abdullah's mother and aunts, have spent so much of their lives solely in the company of their own sex that they have developed a female dialect barely comprehensible to outsiders. They have never shown their faces to men beyond the immediate family, never had a job, never driven a car.

At first glance it might appear that almost all women in the country lead similarly cloistered lives. The overwhelming majority are covered in black from head to toe, with only a narrow open slit for their huge, dark eyes. In Aden, thanks to Marxist precepts on women's emancipation encouraged by the now vanished southern regime, women once burned their veils. But following unification, faces, hair, and other visible female flesh (apart from that of a

Under a withering sun in the Wadi Hadhramaut, women wear hats to keep their heads cool as they

gather clover for cattle. Behind them: a Hadhrami family compound, fortified against tribal raids.

few principled die-hards) have gradually disappeared again.

YET, THIS BEING YEMEN, things are not quite what they seem. Women in the big cities drive as a matter of course. They hold senior jobs in government. Influenced by television and education, their private language is dying out.

Abdullah himself had worked happily at the ancient temple site under the orders of a woman named Selma al-Radi, an Iraqi-born archaeologist who has spent much of the past 20 years in Yemen. Observing al-Radi in forceful command of her team of artisans in the restoration of a historic mosque in the mountain town of Rida, her principal labor for 18 years, or listening as she conferred with her friends among the tribesmen demonstrated to my satisfaction that male Yemenis will accept a woman on her own terms. Those who tried to assert traditional prerogatives soon came up against the rough edge of her tongue. As we strolled the dusty backstreets of Tarim, a very conservative Hadhrami town, a dignitary standing at the door of a religious school made the mistake of assuming, from her lack of a veil, that al-Radi was a Westerner and imperiously waved her away. "How dare you treat people like cattle," she remonstrated in Arabic. "You have no right. Now get back in your school and stay there!" He stood in shock, his mouth open, gazing after us with baffled, mute hostility.

The modern world has in any case transformed the lives of even the most unambitious Yemeni homemakers. In the museum in the Hadhrami town of Saywun I found veiled women thronging an exhibition of traditional cooking implements, common in Yemeni houses only 30 years ago but now mementos of a seemingly remote past. A local youth, recently graduated from Ohio State, was electronically cataloging the items for display on the museum's future website.

In some places the pace of change is even more swift. For miles around the outskirts of Al Mukalla, rows of newly built but unoccupied houses attest to a speculative real estate boom fueled by returnee investment and the high hopes sparked by significant oil and gas reserves discovered by the Canadian Occidental oil corporation. As older fields exploited by



the Hunt oil company near Marib in the center of Yemen run out, CanadianOxy has emerged at the forefront of Yemeni oil production, now pumping 210,000 barrels a day, an amount that is set to increase.

I asked Waleed Jazrawi, an Iraqi-born Canadian who serves as the local CanadianOxy chief, whether he thought operations might be affected—as they have been at the Marib oil fields—by unruly tribal elements that use the pipeline as a target for bombs.

"No," he replied in his well-guarded Sanaa office. "We don't find it violent at all. Usually when people get killed here they're a target."



Mounds of merchandise line the suq in Taizz, one of Yemen's most cosmopolitan cities. Here a daily whirlwind throws together road-weary merchants with mountain folk, farmers, vendors, and housewives. Accordingly, residents pride themselves on an open-minded outlook.

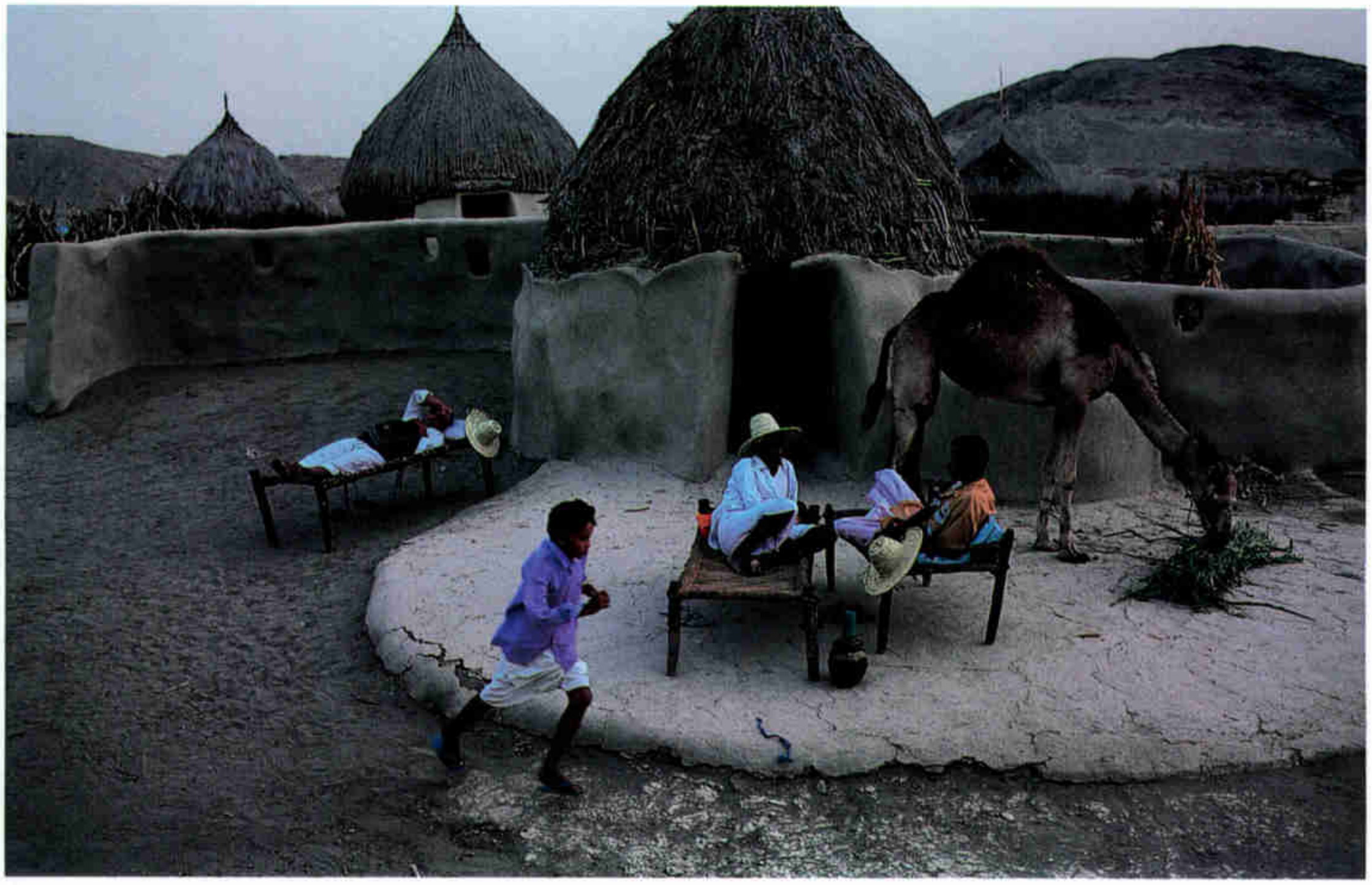
Problems, Jazrawi pointed out, could generally be sorted out at a qat chew.

LEGEND HAS IT that qat was introduced to Yemen by a herder who noticed its stimulating effect on his goats. Trying it for himself, he found the energy to stay awake all night, devoting the time (this being a devout Muslim country) to prayer.

Yemenis cherish their legends: Sanaa was founded by Shem, the eldest son of Noah; the lights of the palace of Ghumdan, the original Sanaa high-rise built around the time of Christ, could be seen in Medina, 700 miles to the north. In a remote and dusty northern village, I came across the rusting remains of a modern Yemeni legend that has spread far and wide: the homemade helicopter, built from metal shelving and parts from a GMC pickup truck, that actually flew. This seemed



After eons of trade, Yemen's tie to Africa is strongest in the Tihamah plain on the Red Sea coast, where Africa colors everything from the face of a girl to mud houses thatched with reeds. Yet the resemblance is only skin-deep, say Yemenis. "Our soul," says one man, "is Arab to the core."



a dubious proposition aeronautically speaking, but villagers retain vivid recollections of the unlikely machine's first and only flight: "The machine rose 40 meters in the air. Then it came straight down again, landing right here." Nothing could shake their memories of the event.

BACK IN SANAA, I thought I might investigate the truth behind an even more recent legend, the jinn-infested apartment block on the airport road that the Dutch ambassador had mentioned. The story had even attracted a French exorcist, who reportedly tried and failed to expel the jinn. On the day of my visit an ashen-faced passerby on the sidewalk outside the building shook my skepticism by announcing that he had just seen a ghostly image float out one window and in another. "God forgive me, God forgive me, it's none of my business," he muttered, and hurried on.

Eventually, two young men emerged from inside and urged me to make a personal inspection. The truth, as they described it, was more prosaic, but telling nonetheless.

The building was owned by the uncle of one of my guides. Unfortunately for the uncle, a high government official coveted the site for a real estate scheme of his own. Repeated efforts, including the billeting of troops during the 1994 civil war, had failed to dislodge the owner, and so the official had hit on the expedient of inserting an announcement in the interior ministry's official bulletin that jinn were in residence, news that soon found its way into the general press.

This imaginative initiative had the desired effect of discouraging tenants, but the owner had remained stubborn, installing his nephew and a friend in one of the apartments to prove the absence of malign spirits. They seemed happy enough, consuming industrial quantities of qat while conducting a flourishing trade in fake antiquities.

While I was inside, my driver, Naji, had cautiously parked a block away. He greeted my safe emergence and report on the facts of the matter with relief.

"You shouldn't have believed it in the first place," he laughed. "You should know that we are the real jinn. All Yemenis are jinn." □

INSIDE Chiquibul

EXPLORING CENTRAL AMERICA'S LONGEST CAVE

Plunging Through

Effort and elation propel caver John Wyeth through a watery canal in the Chiquibul cave system en route to the exit after eight days underground. On a recent expedition cavers mapped a vital link in this labyrinth of four huge caves carved through limestone in Belize and Guatemala by rainwater and the subterranean Chiquibul River.



BY THOMAS MILLER · PHOTOGRAPHS BY STEPHEN ALVAREZ

FIVE HUNDRED FEET below the bright green rain forest, cave diver James Brown slips into the dark green waters of a flooded cave passage called Tunkul Sump. Loaded with lights and two scuba tanks, he unreels a thin white nylon cord, his lifeline back from the unexplored passage. I sit near the sump and wait.

It's April 30, 1999, my sixth expedition to the Chiquibul cave system. On each trip I feel I'm opening books in an underground library that has preserved records of dramatic climate change over time, of the lives of the Maya who once used these caves, and of numerous animal species, living and extinct. This trip will include geologic sampling to estimate the age of the caverns and the impact of regional tectonic motion. We also hope that Brown's dive will answer a question.



Ninety minutes tick by. Finally bubbles spill up to the surface. Weighted with a hundred pounds of gear, Brown wallows out in knee-deep muck and calmly announces that after a dive of 200 feet through the sump he emerged into an airy gallery up to 160 feet wide. It proves to be part of Cebada Cave. We have our answer: Tunkul Cave is physically connected with Cebada to the west, a link that creates a single cave nearly 25 miles in surveyed length—by far the longest in Central America.

Proving that suspected link was a satisfying piece of a puzzle begun in 1984, when Chas Yonge and I first explored Tunkul. Surveying its passages, we wandered into an immense cavity. Our lights lacked power to show a ceiling or walls; we merely sensed boundaries in a night without a sky. Now named Belize Chamber, the room bulges on our map like an anaconda's meal. Measuring almost 1,600 feet long by 600 wide, it is the largest known cave room in the Western Hemisphere. Such revelations have rewarded me and my fellow cavers as we've surveyed the maze of Kabal, Tunkul, *(Continued on page 63)*

A World Below

With gaping invitation a huge sinkhole called Nohoch Ch'en (Maya for "great well") hints at the presence of caves below the rain forest of Belize. Within one of those caves, a 25-foot-tall splatter-cone stalagmite sprouts petals of calcite. By measuring the decay of uranium isotopes in such stalagmites, geologist Joyce Lundberg estimates that the Chiquibul caves began to form at least 800,000 years ago.

No End in Sight

Celestial in size, the giant Sand Passage in Kabal, easternmost of Chiquibul's four caverns, broadens to 130 feet across. "It's so big it's hard to grasp that you're in a cave," says Pete Shifflett, shown standing near the right wall. Every wet season the rising Chiquibul River surges through this room, leaving new ripples on the ancient floor.



Gift of a Vanishing River

From the hills of Belize the Chiquibul River runs west into Guatemala before its waters join other streams and flow northeast to the Caribbean. Along much of its course it runs below ground, where it has carved some of the largest cave passages in the world. Explorers have mapped some 40 convoluted miles and suspect another 20 are yet to be found. Says lead researcher Thomas Miller, "It's like putting together a puzzle in the dark—and we don't know where the pieces are."

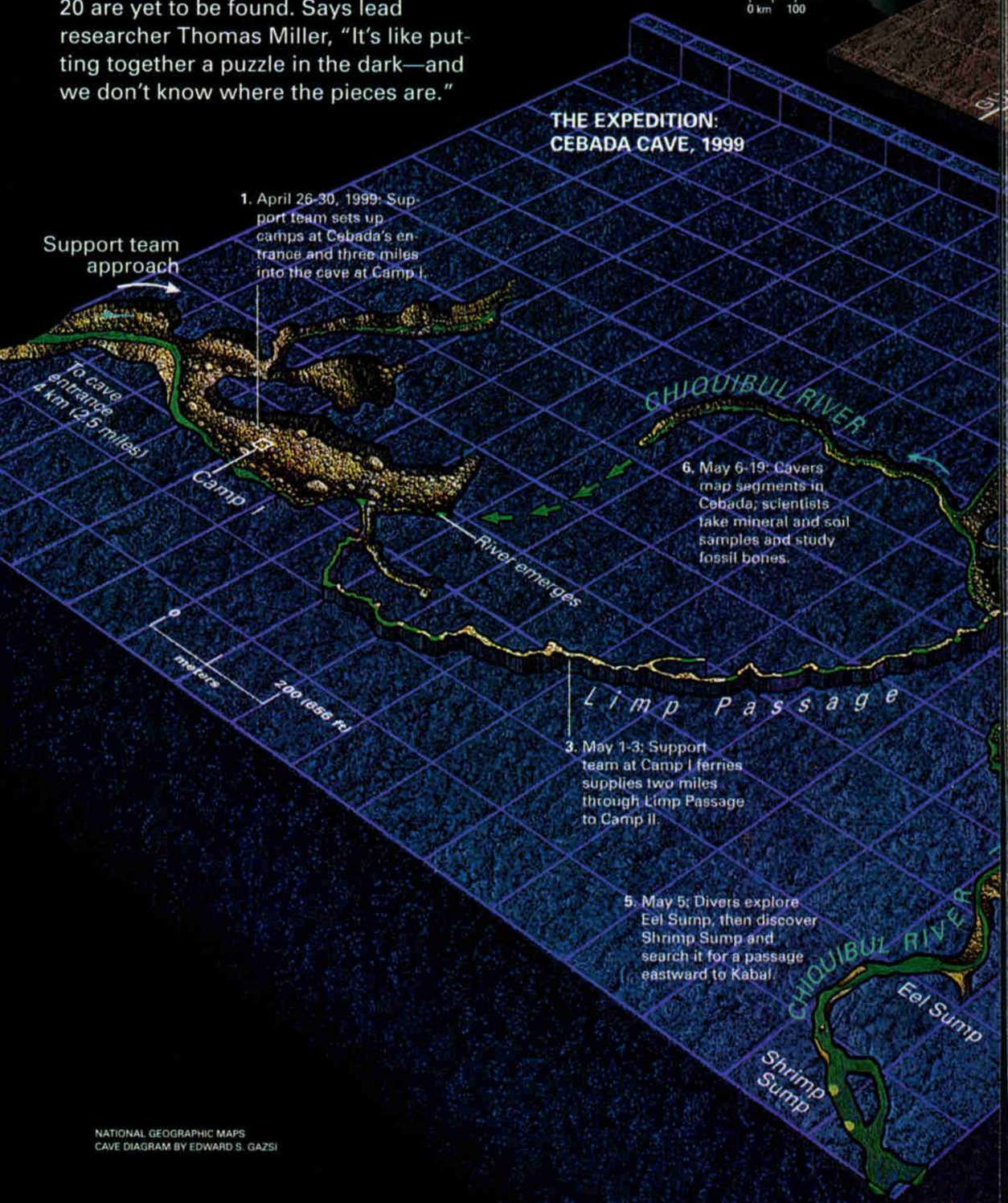


THE REGION



THE CAVE SYSTEM

THE EXPEDITION: CEBADA CAVE, 1999



THE MAPPING OF A CAVE

1982 Author locates Chiquibul cave system in Belize.

1984 Research team discovers Belize Chamber, surveys it, Tunkul Cave, and Kabal, and descends into Nohoch Ch'en.

1986 Surveys Cebada and Xibalba Caves, discovers Mind Proddler, reaches cave entrance in Guatemala and end of Limp Passage.

1988 Descends into Zygote Chamber.

1998 Discovers Eel Sump, Kultun Passage, and possible Cebada route to Tunkul Sump.

1999 Dives sump linking Tunkul to Cebada, dives Eel and Shrimp Sumps. Surveyed cave system totals nearly 40 miles so far.

NATIONAL GEOGRAPHIC MAPS
CAVE DIAGRAM BY EDWARD S. GAZSI

(Continued from page 57) Cebada, and Xibalba, four hydrologically linked caves excavated by the Chiquibul River on the border between Belize and Guatemala.

But not all the revelations have been pleasant. In 1998 we spent a week in Cebada. After enduring chilly swims and body-size crawls through arduous Limp Passage, we followed the Chiquibul upstream, only to be stopped when the cave's ceiling dipped into the river at a sump. As I wrote annoyed comments in my sketchbook, caver Pete Shifflett searched for a bypass and biologist Jean Krejca grabbed an unlucky eel and stuffed it into a bottle of formalin. We named the spot Eel Sump and determined to dive it the following year.

On our return last spring, 14 of us hiked into the rain forest while the British armed forces helicoptered a month's worth of freeze-dried food, cylinders of compressed air, and other supplies to our surface camps at Tunkul and Cebada. We split into two groups. One lowered dive gear down a 130-foot shaft near the Belize Chamber. By entering here, we avoided lugging heavy gear through much of Cebada and the Limp. This group included the four cave divers (myself, Brown, Shifflett, and Krejca), who would swim the suspected sump link between Tunkul and Cebada. A second group entered Cebada and ferried supplies to Camp II, where they would meet us after our dives.

After Tunkul Sump we headed for the unknown waters of Eel Sump, hoping to find an eastward link to Kabal. It was absurdly short, 45 feet or so. Past it, and beyond the reach of any support crew, we slogged up the Chiquibul until the cave ceiling again dropped at a spot we named Shrimp Sump. Brown dove it twice but found no clear way forward. I followed his line to a depth of 50 feet, then surfaced in a pool. I scanned the damp, shadowy walls for a passage. Finally discouraged, I floated in the humid darkness and let my imagination show me sunken passages I hope to see one day.

RESEARCH PROJECT

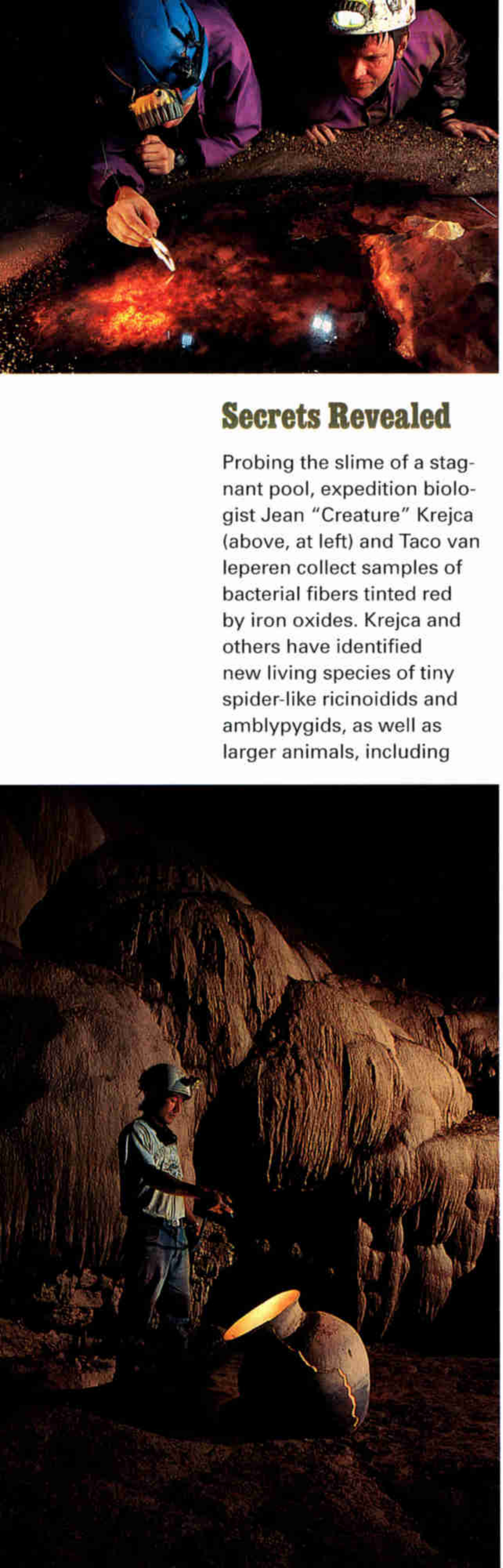
Supported in part by your Society



Frozen in Time

Forever draped in a calcite shroud, the bones of a bat adorn a room in Cebada Cave. Thousands of bat skeletons representing several species—including a large extinct vampire bat—rest here. Undisturbed by scavengers, the corpses decay slowly, leaving perfectly intact bones that date back 10,000 years or more.

THOMAS MILLER is a geologist at the University of Puerto Rico. His Chiquibul studies have been funded in part by the Society's Committee for Research and Exploration. Photographer STEPHEN ALVAREZ covered the caves of Borneo's White Mountain for the September 1998 GEOGRAPHIC.
Explore Chiquibul yourself at *www.nationalgeographic.com/chiquibul.*



Secrets Revealed

Probing the slime of a stagnant pool, expedition biologist Jean "Creature" Krejca (above, at left) and Taco van Ieperen collect samples of bacterial fibers tinted red by iron oxides. Krejca and others have identified new living species of tiny spider-like ricinoidids and amblypygids, as well as larger animals, including a blind shrimp and a translucent crab.

Ancient mammals also haunt the caves of Chiquibul. The 10,000-year-old bones of a bear lie in a regally columned tomb in Cebada Cave (right). Paleontologist Greg McDonald of the U.S. National Park Service believes that this is a female cub of the extinct species *Tremarctos floridanus.* "This find extends the known range of the species nearly a thousand miles farther south," says McDonald. "Either this bear was more adaptive to tropical climates or the environment in Belize was drier at the end of the last ice age than we thought."

Maya people, too, once entered these caves to obtain water and to honor their gods. Clay whistles, grinding stones, incense burners, and altars are among the many artifacts logged by archaeologist Logan McNatt for the Belize Department of Archaeology. Near a flowstone wall in Kabal, Enrique Soquil examines a cracked olla (left), one of many large, plain pots left here by the Maya some 1,200 years ago. At that time tens of thousands of Maya lived in the now uninhabited rain forest above the cave.

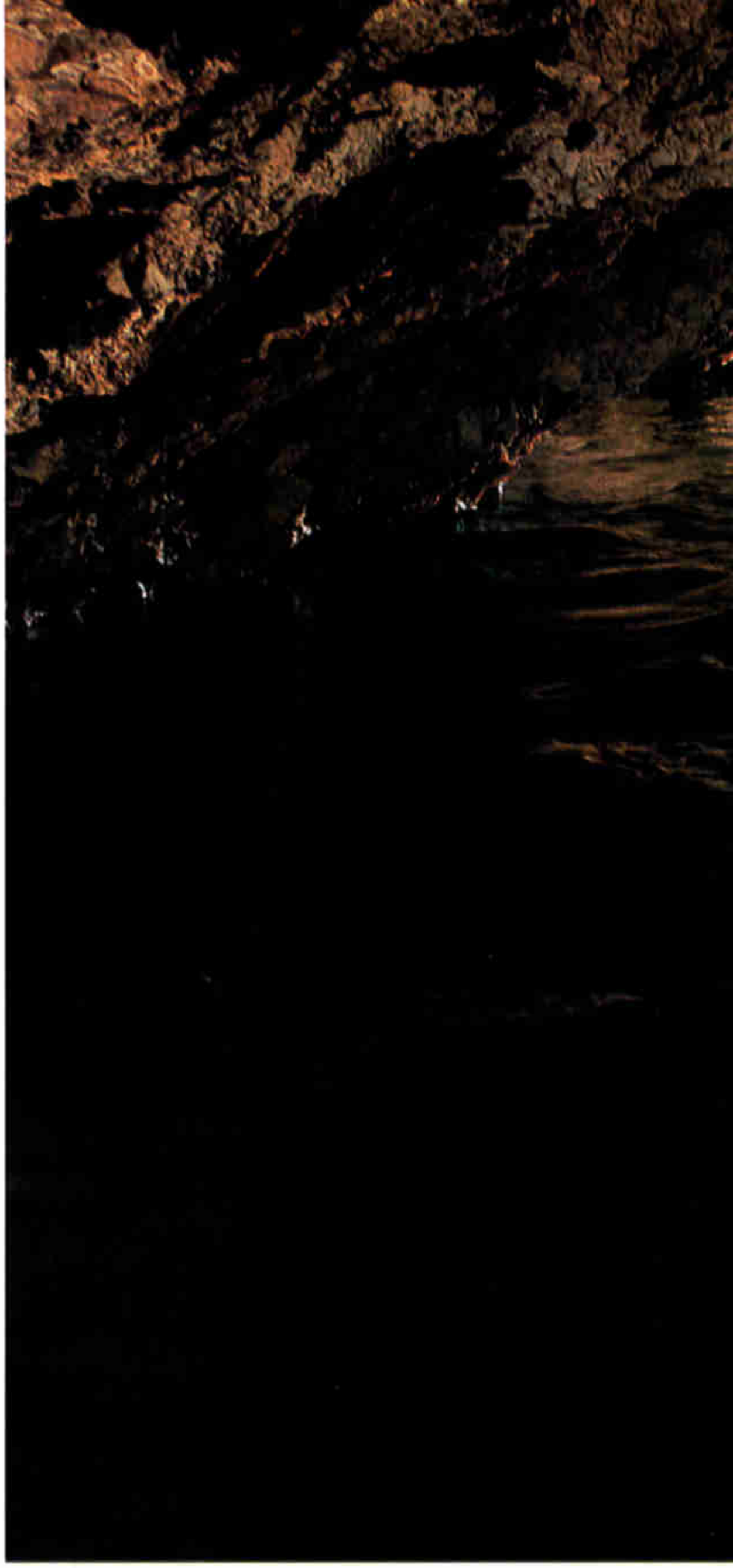


Cathedral in Stone

Soaring columns inspire awe in a passage of Cebada Cave called Mind Proddler. Geologic studies suggest that this is the oldest of perhaps five cave levels cut by the Chiquibul River.

Later levels were formed lower down, as earthquakes and tectonic motion caused periodic uplifts, which Miller calculates raise this area about three feet every 10,000 years.





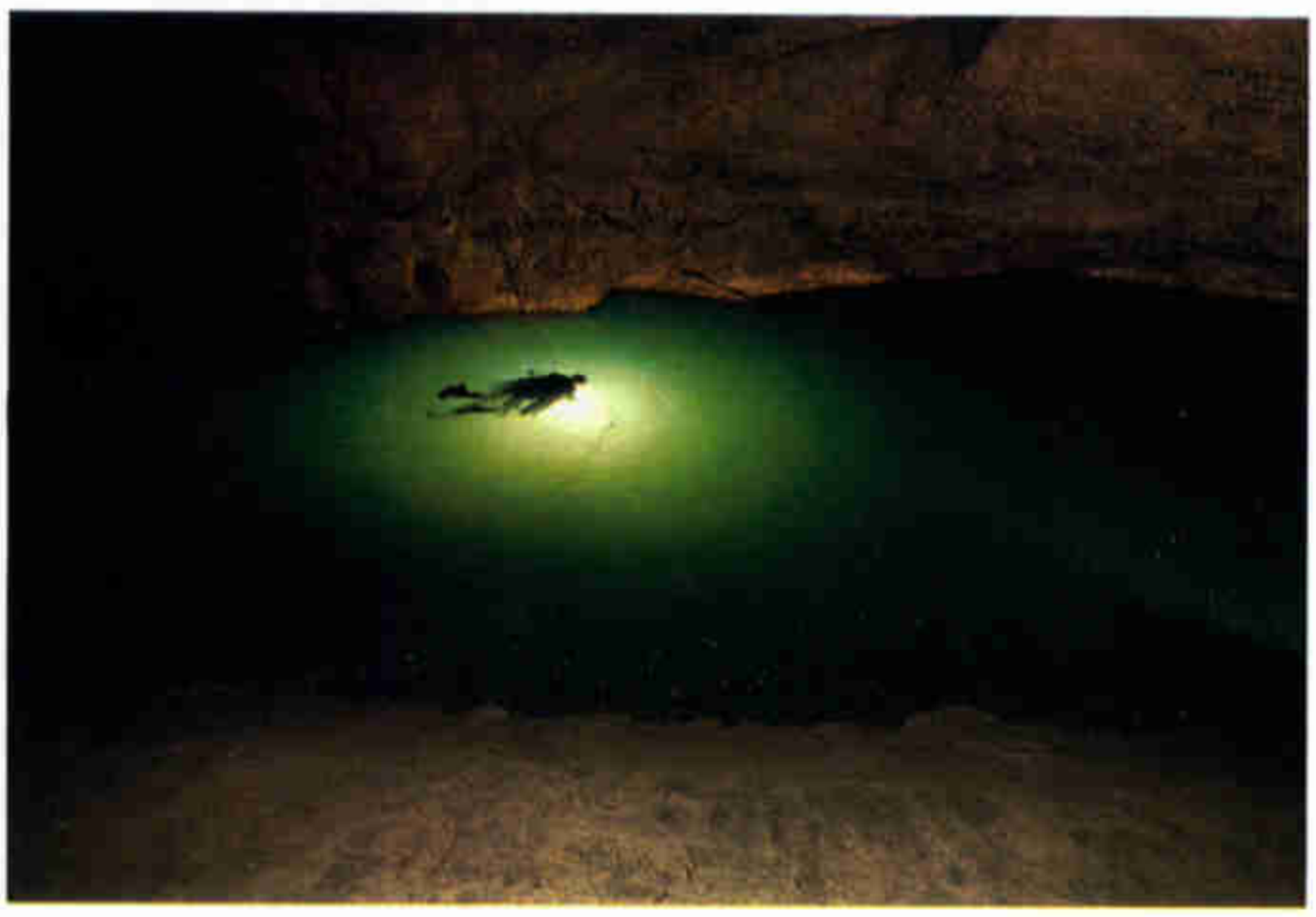
Belly of the Beast

Struggling upstream through the guts of Cebada, Stan Allison (front to back), John Wyeth, Gosia Roemer, and the author haul diving gear along the mile-long stretch from Camp II to Eel Sump. Such treks through Cebada, some 500 feet underground, are limited to the dry season; a sudden river rise during wet-season floods could trap the team with no way out. Even the dry-season current is swift. Much of the way their feet don't touch bottom. Unable to see the razor-sharp rocks that lie below the surface, many of the cavers bear scars as souvenirs of the trip.

Allison, Wyeth, and Roemer were members of the expedition's vital support crew. Hailing from as far away as Poland in Roemer's case and Indonesia in Wyeth's, they helped establish underground camps and transport scuba tanks and gear, sometimes lowering equipment on ropes down vertical shafts, then floating it downriver on inflated car inner tubes. Team members Pete Shifflett and Jim Locascio developed powerful light-emitting-diode headlamps to help beat back the dark.

Because air temperatures in these tropical caves average a mild 74°F, camp life is relatively pleasant. But diving into Tunkul Sump—the first cave diving ever done in the Chiquibul system—was otherworldly. For Miller, entering the chilly waters of the sump (right) was "like being in outer space, where all is weightless, dark, and unknown."





Into the Light

Daylight splashes a silent pool near the Zactun entrance of the cave named Xibalba, Maya for "underworld." These columns, which have taken 170,000 years to form, endure against annual floods that can raise the Chiquibul River 70 feet or more. The submerged river flows through Xibalba, then spills out from the cave in a rush of rapids at the base of a Guatemalan gorge.

Like Kabal in the east, this westernmost of the system's caves holds one of the world's largest underground passages. For two miles it averages 260 feet across. Such intriguing features as vaulted rooms, tight tunnels, and watery sumps give these caves their appeal. As far as Miller's team knows, it has explored everything with air in it. What remains is to find the flooded underground links between Kabal and Cebada and between Cebada and Xibalba—goals that will bring the team back in the years ahead. □





A report from the National Geographic

Update

Society's Committee for Research and Exploration

from the field

ON BARE MOUNTAINS, beneath the seas, in ancient burial chambers, scientists and explorers worldwide expand our knowledge through National Geographic–funded projects and expeditions. Here are some of the grantees at work.

Follow the committee's work online at *www.nationalgeographic.com/research*.

New Zealand

Whaling in Stone

His team's heavy equipment has cracked open the rock; now Ewan Fordyce uses an engraving pen, precise as a dentist's drill, to uncover bones of a fossil baleen whale. Working in southern New Zealand, the University of Otago geologist has found whales 26 million years old.

ROBERT CLARK

"Countries need help instituting conservation

Turkmenistan

Looking Out for Wildlife

"When the Russians pulled out of Turkmenistan in 1991, there were few native biologists to take their place. Our Committee for Research and Exploration [CRE] grant helps fill that hole," says Raul Valdez of New Mexico State University, who went to the former Soviet republic to catalog urial populations. With the help of his wife, Gris (standing), and local biologist Islam Ishanov (with spotting scope), Valdez stalks the sheep from a 500-foot cliff in the Badkhyz Nature Reserve.

projects, and the CRE helps do that."—Raul Valdez

Mexico

Secrets of an Ancient Pyramid

Among the least understood monuments at Teotihuacan, the 2,000-year-old ruins outside Mexico City, is the Pyramid of the Moon. But a key piece of the puzzle may have been found last summer when a team led by Saburo Sugiyama, at right, of Japan's Aichi Prefectural University discovered a chamber containing jewelry, obsidian blades—and four human skeletons.

RAUL VALDEZ (OPPOSITE); JESÚS LÓPEZ

Patagonia

Canceled Species

After 145 million years a pliosaur is uncovered in South America by Zulma Gasparini of the Universidad Nacional de La Plata in Argentina. "We found part of the spinal column and pectoral and pelvic girdles," she said. "This summer we will look for the cranium." National pride in Gasparini's discoveries has led Argentina to immortalize the dinosaurs on a set of postage stamps (below).





MARK THIESSEN, NGS STAFF (LEFT); ANTONIO ALTAMIRANO

"We saw the effects of gold mine cyanide leakage,

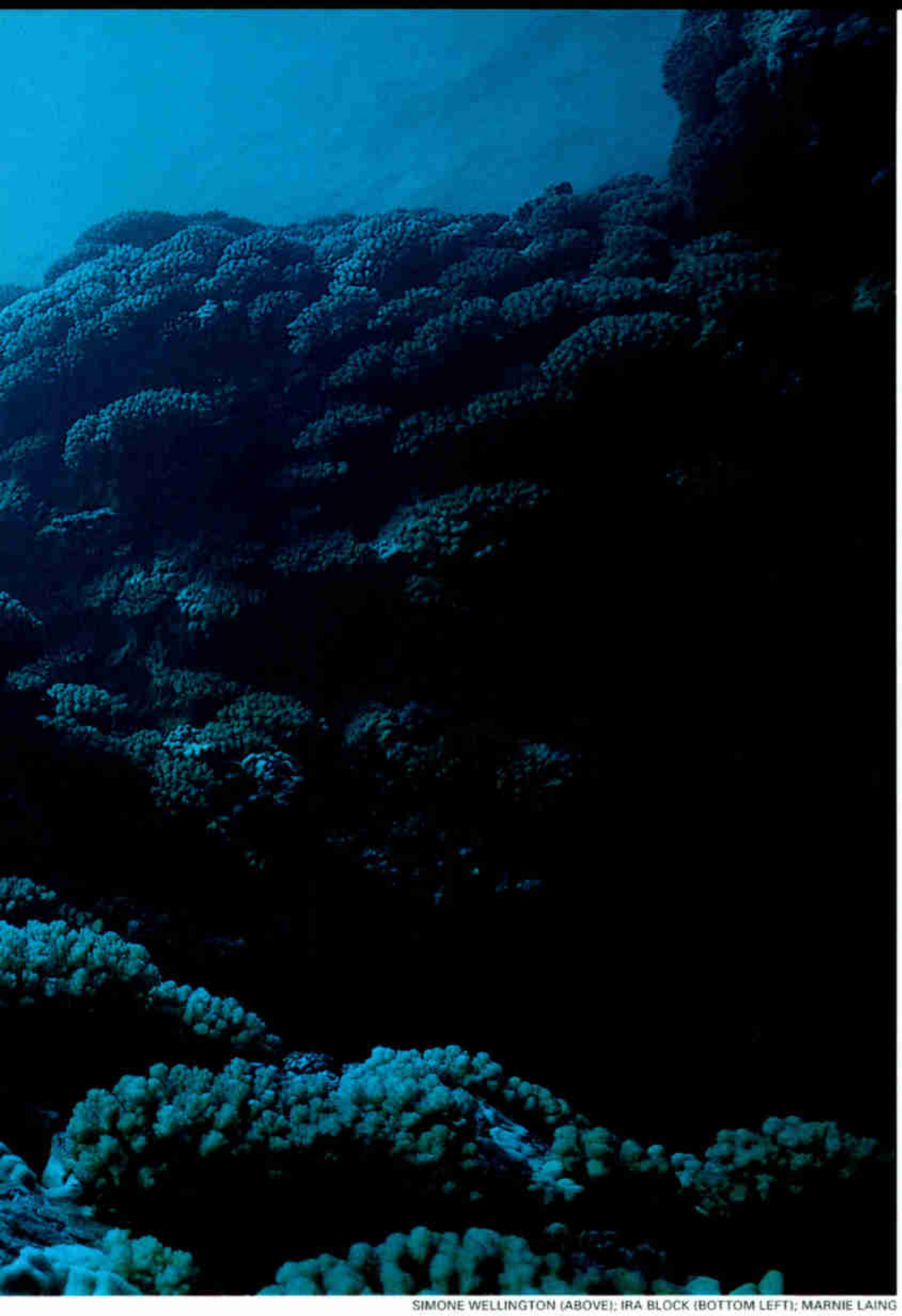
Chesapeake Bay

Ancient Impact

A 51-mile-wide crater, carved by a meteorite some 35 million years ago, cuts across today's Chesapeake Bay. With underwater probes, U.S. Geological Survey scientists like grantee Wylie Poag and technician Dave Nichols (right) are mapping the crater and gauging possible earthquake threats from faults associated with the impact.



which killed a reef immediately."—Heather Holden



SIMONE WELLINGTON (ABOVE); IRA BLOCK (BOTTOM LEFT); MARNIE LAING

Easter Island

Deep Diving

Oceanographers have long wondered if corals in the eastern Pacific Ocean are closely related to those in the west or if they have developed separately. To find out, University of Houston scientist Jerry Wellington is spending two years hovering over coral reefs off Easter Island (left), as well as near the Galápagos Islands, Panama, and Tahiti. Early findings indicate major differences among corals in these locales, so more swims are necessary—though most of his work, Wellington insists, "takes place at a lab bench."

Fiji

Coral Health

Measuring the amount of light reflected by healthy coral off Fiji, Heather Holden of the National University of Singapore finds ways to evaluate coral conditions worldwide. Says Holden, "Our grant has enabled us to create a robust data set. We hope it will increase people's awareness of the need to monitor coral reefs."



"I got so many calls for Everest's height that

Nepal

How High Is the Top of the World?

With Mount Everest's summit in sight, climbers prepare for their final ascent. This 1998 team laid the groundwork for last spring's CRE Everest climb, which placed a global positioning system (GPS) receiver on top. "By satellite," says grantee Bradford Washburn, honorary director of Boston's Museum of Science, "the elevation can be known within one spherical centimeter." Everest's official GPS height: 29,035 feet, seven feet higher than the old estimate.

I barely had time to calculate it!"—Bradford Washburn

Arkansas

Saving a Roadside Mastodon

While dredging out an agricultural ditch last April, a county contractor named George King got a surprise: a remarkably preserved mastodon skeleton. Since then, in the shadow of a Highway 158 overpass, University of Arkansas archaeologist Julie Morrow has been excavating the site with help from members of the Arkansas Archeological Society. This lower jaw came complete with teeth, plus a bonus, she says: "There's enough protein in one tooth to carbon-date it!"



CHARLES CORFIELD (OPPOSITE); KENNETH GARRETT (ABOVE); ROBERT CLARK

Pakistan

Armed Guard for a Walking Whale

Northeastern Ohio Universities College of Medicine expert Hans Thewissen is used to having weapon-wielding police stand by as he digs in Pakistan. "Police serve as guides and interpreters and keep us from going where people aren't friendly," says Thewissen, who found the only full skeleton of a land-roving ancestor of today's whale. "The guns don't bother me," he says. "In these hills they're more of a status symbol than a weapon." □



A SPECIAL PLACE

The Patience of a Saint

SAN PEDRO

RIVER

Shaded from a parching sun by cotton-wood and willow, the San Pedro waters a narrow oasis in Arizona's Sonoran Desert filled with a profusion of life, including millions of migrating birds. Thirsty communities in the valley could someday drink the river dry.

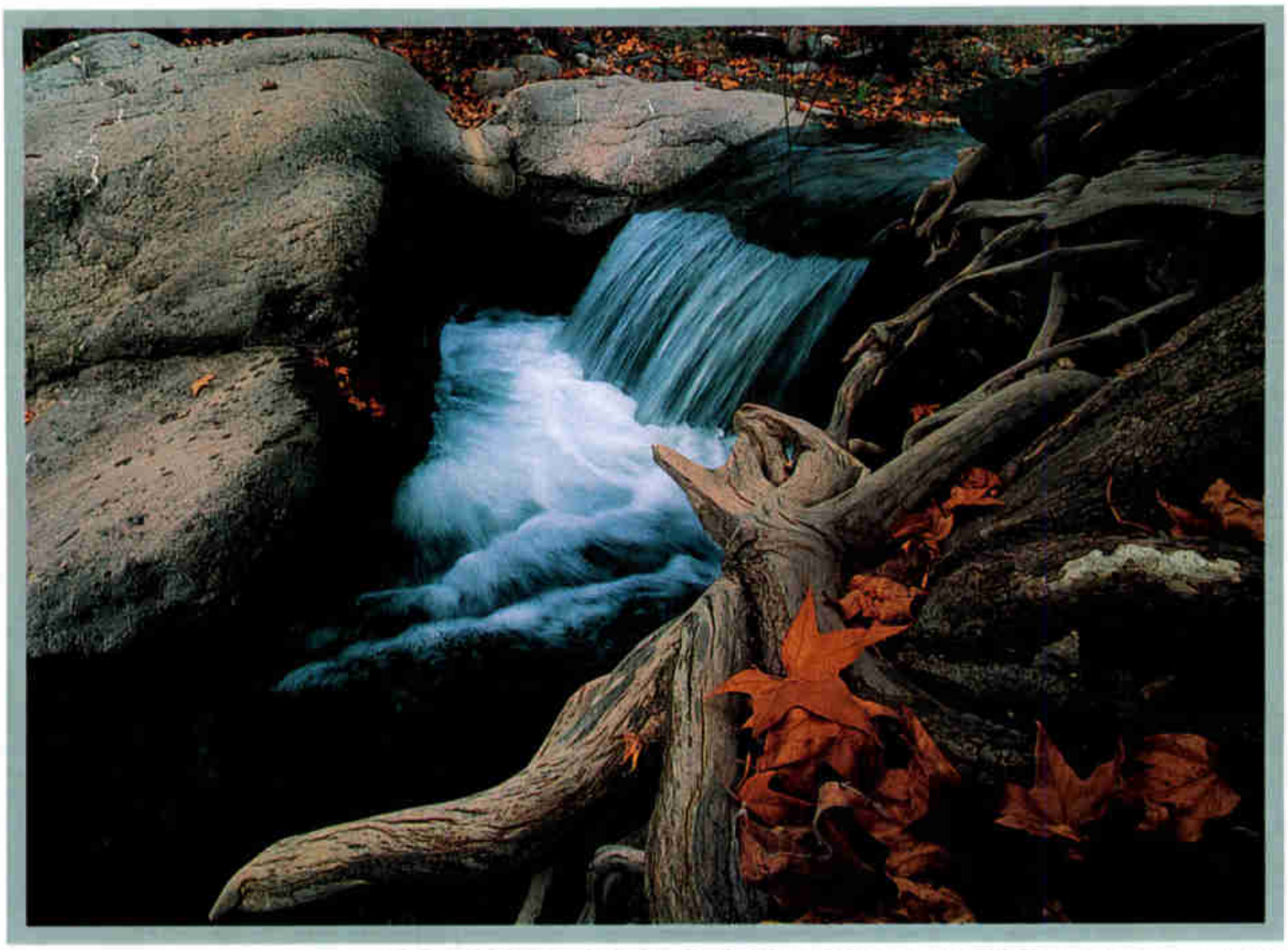
By BARBARA KINGSOLVER

Photographs by
ANNIE GRIFFITHS BELT

TRAPPED, POISONED, AND SHOT, *the gray wolf nearly vanished from*

U.S. wilds, but this subspecies may still roam the San Pedro in Mexico.

CAPTIVE MEXICAN GRAY WOLF *(CANIS LUPUS BAILEYI)*, ARIZONA-SONORA DESERT MUSEUM



HOT SPRINGS CREEK, MULESHOE RANCH COOPERATIVE MANAGEMENT AREA

WHEN I WAS NINE YEARS OLD, I jumped across the Mississippi. My family had sought out its headwaters in Itasca State Park, Minnesota, where a special trail showed the way for adventurers with this feat in mind. I took my leap reverently. My parents let me know this modest stream I'd taken in stride was actually one of Earth's great corridors, dominion of paddleboats and Huck Finn, prime mover of flood, fertility, and commerce across our land.

However we might long to re-create the landmark events of childhood for our own children, water passes on. You can't—as Heracleitus put it—step in the same river twice. Nowadays when my family sets out for a lesson in river, we drive southeast from our Tucson home to a narrow, meandering cottonwood forest where our kids may attempt to vault the San Pedro. They've done it often, and sometimes don't even get very wet. Where its headwaters cross from Mexico into Arizona, this river is barely three feet across. As it flows north across some 150 miles of desert, it rarely gets much wider. In the scheme of human commerce it's an unimpressive trickle. Mostly it's a sparkling anomaly for sunstruck eyes, a thread of blue-green relief.

In summer this modest saint invites us down from the blazing heat into a willowy tunnel of cool shade, birdsong, and the velvet brown scent of riverbank. We take unhurried hikes, reading the dappled script of animal tracks and the driftwood history of flood and drought embedded in the steep banks. The sight of a vermilion flycatcher leaves us breathless every time—he's not just a bird but

Prizewinning fiction writer BARBARA KINGSOLVER received graduate training in ecology and evolutionary biology and says she is a biologist at heart. She and her husband, Steven Hopp, an ornithologist at the University of Arizona who collaborated on this article, live in Tucson. Photographer ANNIE GRIFFITHS BELT is a frequent contributor. Her coverage of the Yellowstone River appeared in April 1997.

a punctuation mark on the air, printed in red ink, read out loud as a gasp. The kids dance barefoot between sandbars, believing they've found the Secret Garden. For the space of an afternoon we're sheltered from the prickly reality of the desert where we live. Most human visitors to the San Pedro appreciate it for about the same reasons they value gold: It sparkles, and it's rare.

From a resident's point of view, though, the price of gold couldn't touch this family home. For the water umbel spreading delicate roots in a lucid pool, the leopard frog peering out through a veil of duckweed, the brush-prowling ocelot, and the bright-feathered birds that must cross this hostile expanse of land or find a living from it, the San Pedro is a corridor of unparalleled importance. Nearly a third of the river's 150 miles and 58,000 acres of adjacent land have been protected since 1988 as the San Pedro Riparian National Conservation Area. The Nature Conservancy has named it one of Earth's Last Great Places.

To jump across this river with the right measure of reverence requires an animal frame of mind: 82 species of mammals—a community unmatched anywhere north of the tropics—inhabit this valley. Also hiding out here are 43 kinds of reptiles and amphibians, including the Ramsey Canyon leopard frog—a bizarre critter that calls (as if he knows it's a big, harsh desert out there) from underwater. The San Pedro harbors the richest, most dense and diverse inland bird population in the United States as well—385 species. It's one of the last nesting sites for southwestern willow flycatchers and western yellow-billed cuckoos; green kingfishers breed only here and in southern Texas. For millions of migratory birds traveling from winter food in Central America to their northern breeding grounds, there is one reliable passage on which life depends. Just this one.

I lead my children down its banks in the hope they'll come to recognize in the San Pedro the might and consequence of that splendid word, "river." Never mind that Huck Finn wouldn't have troubled himself to spit across it. As our girls stoop at the edge of a riffle, peering into the clear, fast water, my husband and I talk to them about heroic navigational feats undertaken not by paddle and steam but feathered wing. Our Tucson-born children are more accustomed to ephemeral desert streams that roar briefly after a storm, leaving behind bleached, stony channels that stay dry for weeks or months until the next good rain.

"This one never, ever dries up. Wow," our eldest observes. *(Continued on page 92)*



Flowing north out of Mexico, the San Pedro vanishes underground along intermittent stretches. In the San Pedro Riparian National Conservation Area, the forest is withering as wells near Sierra Vista tap into the river's subterranean sources.

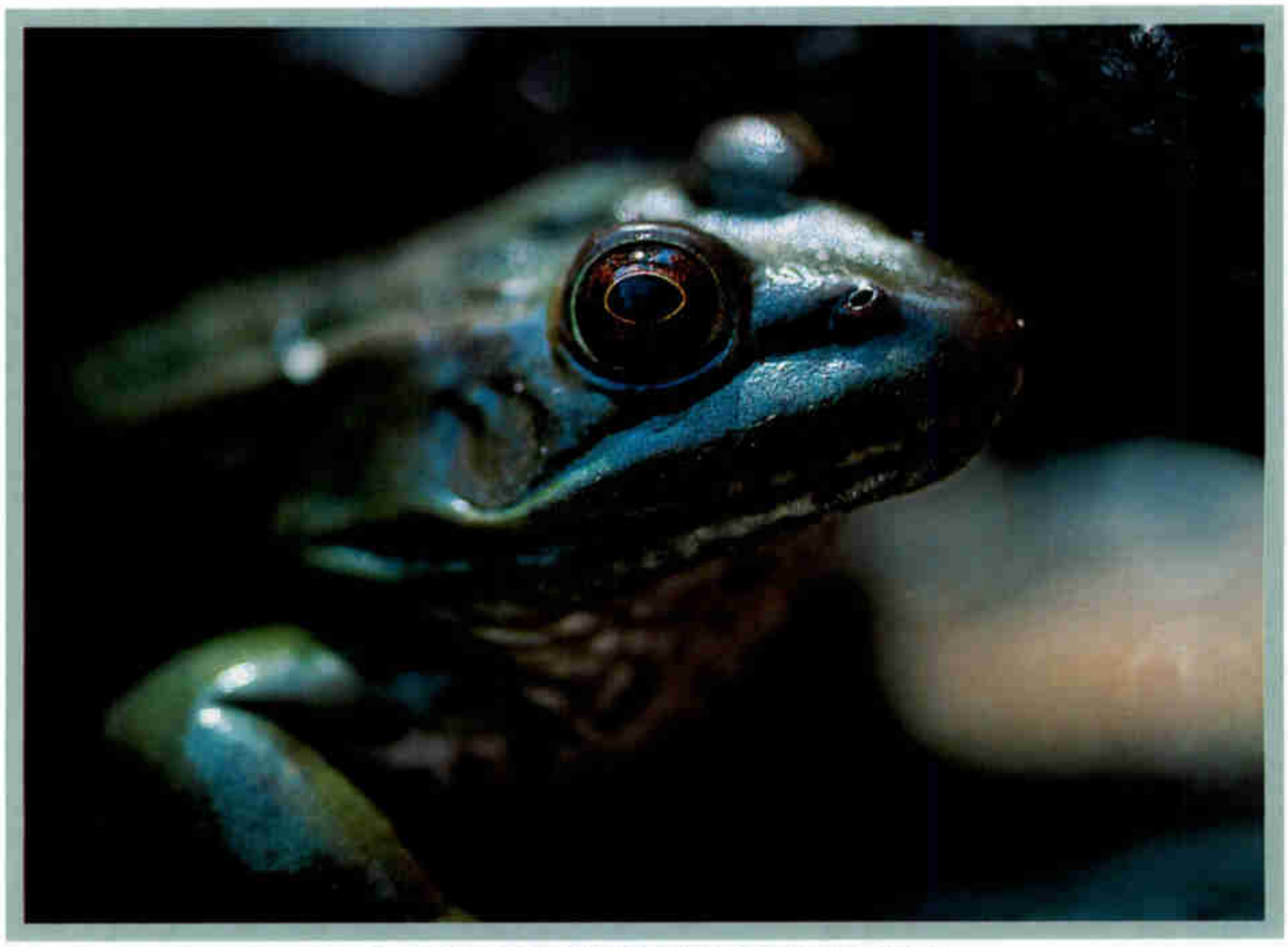
DRY WASHES CARVE one of many ranges that line the San Pedro Valley,

replenishing the river after infrequent summer and winter rains.

RINCON MOUNTAINS



BUTTERFLIES (*EUREMIA PROTERPIA*, LEFT; *NEOPHASIA TERLOOTII*, RIGHT), RAMSEY CANYON PRESERVE

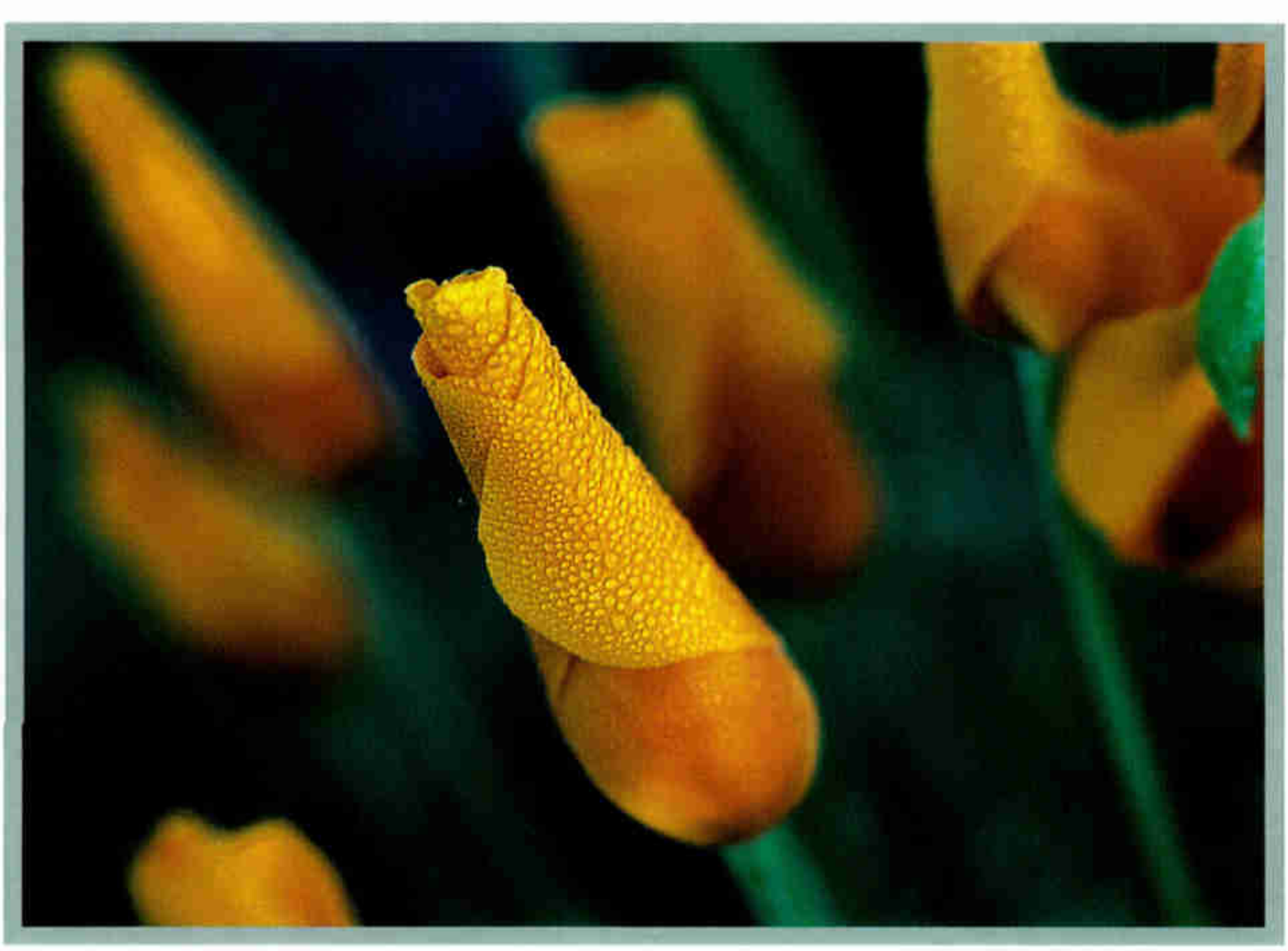


RAMSEY CANYON LEOPARD FROG *(RANA SUBAQUAVOCALIS)*, RAMSEY CANYON

Dams and canals have drained most rivers in the Southwest, leaving the San Pedro a slender refuge in a sere landscape at the crossroads of four ecosystems—the Sonoran and Chihuahuan deserts and the Rocky and Sierra Madre mountains. Conservationists



VERMILION FLYCATCHER *(PYROCEPHALUS RUBINUS)*, NEAR BENSON



MEXICAN POPPY *(ESCHSCHOLTZIA MEXICANA)*, NEAR REDINGTON

call the river valley a "biological treasure chest" because it holds one of the most varied collections of species in the U.S., including a frog that numbers fewer than a hundred adults (lower left) and birds that travel this north-south corridor during spring and fall.



A STONE'S THROW *from the river the desert resumes, a land where water*

is sealed away in thick-skinned cactuses or buried deep underground.

SAGUARO CACTUS *(CARNEGEIA GIGANTEA)*, NEAR REDINGTON

(Continued from page 85) "There could be fish living in there." Our youngest, meanwhile, hurtles toward the sandy shallows crying, "Clothes off!" This may or may not be reverence, but most children are good at the animal frame of mind.

Within the leafy protectorate of the conservation area, most of the river is flanked by a trail, and much of it we've walked, in sections as long as a Saturday and a small child's legs. We hike northward with the flow, guessing the river's intentions as it braids into sandbars and shallows. Sometimes it nearly disappears, but stands of young cottonwoods testify to permanent flow just under the surface. It's more troubling to find a grove of old trees with no young ones at their feet; this means the water table, depleted by nearby wells, has dropped too far for saplings to take hold. If it continues to drop, eventually even the grandfather cottonwoods that constitute the backbone of this ecosystem won't find moisture to sustain themselves.

When we stop to listen for the yellow-breasted chat in a thicket of Mexican elders or scan the water ahead for the greenish glint of a kingfisher's wings—we have in the back of our minds, always, the health of this river. We visit the San Pedro as one visits a beloved, elderly relative. You don't talk about the inevitable, but you think about it a lot.

Rivers like this were once common in the Southwest, with permanent flow supporting long corridors of cottonwood-willow gallery forest that netted the body of the Sonoran Desert like veins. Now, in a land bled dry by agriculture and population growth, only 5 percent of the original forest remains. Riparian species have become concentrated in disparate fragments of creekside habitat. The species list is impressive, but among many orders of animals and plants it's not as long as the roll call of those that have perished quietly. (Of the 13 species of fish originally native to the San Pedro, for instance, 11 are gone.) Beavers used to dam the rivers into strings of marshy pools, keeping the water table high, but they were hunted out long ago. It's no surprise to a desert hiker, anymore, to top a hill and look down on a ghost parade of giant, leafless cottonwoods snaking through the valley below, dying in place, marking a watercourse that has gone and won't be back.



BLACK-TAILED JACKRABBIT *(LEPUS CALIFORNICUS),* NORTH OF BENSON

THE SAN PEDRO somehow perseveres. Scattered along its meandering course are artifacts of countless human encroachments, beginning with the Clovis people who arrived in this valley 11,000 years ago, when woolly elephants roamed our continent. Hunting these marshes and grasslands with flint-headed spears, the Clovis settlers established the most successful North American population archaeologists have found from that era. The Mogollon and Hohokam later built on their foundations but were gone by the time the Spanish arrived. After Coronado's exploratory party beat down this path in 1540, the San Pedro became the point of entry for Spanish settlers in the Southwest until Apache raids forced them to find other routes. Three centuries later pioneers from the East rushed to lay their claims to water sources as the only strategy for surviving here on an eastern bureaucrat's idea of a homestead allotment. One hundred sixty acres of desert will support a herd of pack rats, but not a subsistence farm. With these homestead plots strung out like beads up the watercourse, though, and huge tracts of adjacent desert largely unoccupied, each rancher with a water hole had an effective claim on many thousand acres of rangeland.

Now the family cemeteries of homesteaders are tucked back among the trees, along with the crumbling adobe ghosts of boomtowns whose economies lived and died on mining. A roaring mill on the riverbank once pulverized silver ore hauled in by mule from nearby Tombstone. The river provided water for processing and a handy place to dump the toxic by-products. Now we explore these ruins gingerly, cautioning the kids not to climb on fragile walls or impale themselves on scrap iron as they try to spy pottery sherds and interesting junk. It's tempting to see these remnants as reassurance —to believe our own century's claims on the river will someday disappear just as gracefully into San Pedro's patient embrace.



GOPHER SNAKE *(PITUOPHIS MELANOLEUCUS)*, GRAY HAWK RANCH

But since the day Coronado first guided his horses through tall sacaton grass in this valley, skirting a marshy river that was hundreds of feet across, we've changed the face of the land almost unimaginably. Now the river is channelized between steep banks and so reduced that at one point, near the farming town of Benson, the entire flow runs through an irrigation sluice. It's a dramatic ecology lesson, largely wrought by the subtraction of just one native from the riparian community and the addition of one outsider: the beaver and the free-range cow.

Ranchers are testy about their claim here; it's a tough enough life they've inherited without city-bred environmentalists challenging their rights to graze and irrigate. But now, as the Sunbelt booms, farmers and environmentalists

RAREST OF RIVERS, *the San Pedro evokes the words of Edward Abbey:*

"Nowhere is water so beautiful as in the desert, for nowhere else is it so scarce."

FREMONT COTTONWOODS AND MESQUITE, SAN PEDRO RIPARIAN NATIONAL CONSERVATION AREA

find their voices equally drowned by a new, louder demand from urban consumers. Historically, most of Arizona's water has gone to agriculture—80 percent at present, with the remainder divided between industrial and municipal use. But the state's department of water resources predicts that municipal consumption will double in the next 50 years. Much of the population growth is expected in southeastern Arizona, where the San Pedro flows.

The Fort Huachuca army base and burgeoning city of Sierra Vista flank the San Pedro, drinking up groundwater from an underground depression that's diverting and depleting the same aquifer that supports the river and its many forms of life. As the trees die, fingers point in every direction, for on a map this corridor resembles a patchwork quilt: ranchland, nature preserve, townships, and government grazing leases. A growing number of residents and environmentally minded Arizonans love this river for what it is, rather than for what they can take from it. Working together with organizations on both sides of the international border, their task is to fight against the clock to set pieces of the water table and crucial tributaries out of reach of human depletion. But a river doesn't flow in pieces. Migratory routes can't skip over private property, and a fish has little use for a river that runs 90 percent of the time.



In 1996 the San Pedro's troubles came to the attention of the Commission for Environmental Cooperation, newly created by NAFTA. A study of the crucial migratory corridor connecting Mexico, the U.S., and Canada was an appropriate first major undertaking for this trinational effort at cooperative environmental responsibility. Its findings were unequivocal: At the present rate of consumption, human occupancy will dry up the San Pedro in a matter of decades. Capping municipal growth here, limiting irrigation, and closing Fort Huachuca would significantly extend the river's life, but the study concedes these are costly measures in human terms.

How is it possible to argue the San Pedro's case in a human tongue whose every word for "value" is tied to the gold standard of human prosperity? This blue-green slice of life, fiercely bounded on every side, will persist for all it's worth. To themselves and one another, these lives mean the world. But their delicate finned and feathered hopes are at this moment being weighed against thirsts beyond their ken.

This knowledge makes it harder, each time, to return to our beloved river, but impossible also to stay away. We go back in every season now, not just for cool relief in summer but to witness the autumn migration of hawks and stand under trembling cottonwoods as they cast golden leaves from their white-skinned arms. In winter we kneel at the base of a bare, old netleaf hackberry to place our palms against its bark, feeling the mysterious rows of raised bumps that stipple the trunk like a manuscript in Braille. What can we read there? How long before the pages of this book peel and dry to dust?



YUCCA *(YUCCA SCHOTTII)*, SOUTH OF BENSON

AT THE END of our Saturday hike we leave the scent of mud and moss and find a path through dense elders into the sparser shade of mesquites and, finally, the end of the trail. In the parking lot we hesitate, finding that a vermilion flycatcher has taken a position in a branch above our car. He sits like a sentry with his puffed-out chest, sallying out suddenly to snap a mosquito from the air, then returning to his post. For several minutes we watch him from a distance, unwilling to intrude on a territory he's claimed so convincingly.

Eventually he dashes off, startled by a car that has bumped down the gravel off-ramp from the highway. A station wagon from Ohio. An elderly tourist climbs out, stretches, and takes a look around.

"What is this place anyway?"

"The San Pedro River," we answer, more or less reverently.

"A river," he says, casting a dubious eye on the cactus-studded hills around us. "How big is it?"

We glance at each other, abashed for our river. Evidently this is a question we can't answer. "About three feet across" couldn't possibly be right.

As big as life, then. Just that. □

CHEWING CLAY *For morning sickness Georgia's Ruth Anne Joiner swears by the old-time remedy of eating kaolin, or white clay. Doctors warn against it, but some women crave it, especially during pregnancy.*

Nature's Rx

From the forests of Madagascar to the clay pits of Georgia, people all over the world rely on nature to treat what ails them.

BY JOEL L. SWERDLOW • PHOTOGRAPHS BY LYNN JOHNSON

ASSISTANT EDITOR

Outdoor Apothecary

With a wave of her wand, herb gardener Cathy Webb waters a bank of healing herbs —valerian, echinacea, and hyssop—at Avena Botanicals in Maine. Made into tinctures and salves, these plants are used to treat ailments ranging from insomnia to colds.

PARTY SOUNDS FLOAT UP from a swimming pool in Washington, D.C. Twenty children shout and splash, toss balls, and snack on sandwiches, cookies, chips, and sodas. The guest of honor is nine-year-old Audra Shapiro, who has just finished two years of chemotherapy and whose leukemia is in complete remission. Her recovery from this cancer depended on a plant that originated halfway around the world.

Until the early 1960s Audra's disease would have meant sure death. Now the long-term survival rate for childhood leukemia is above 90 percent, thanks in part to vincristine, a chemotherapeutic drug made from the Madagascar rosy periwinkle. Vinblastine, another drug made from the same plant, helps cure most cases of Hodgkin's disease.

Plants like the periwinkle have contributed to the development of 25 to 50 percent of all prescription drugs used in the United States, either directly or by providing biochemical models, or templates, used to make synthetic compounds. Digitalis, which is used to treat chronic heart failure, comes from the leaves of the foxglove plant, and ephedrine, a component of many commonly prescribed



respiratory medicines, is derived from a chemical formula from the ephedra plant. But overall, in the past 40 years there has been little development of new plant-based pharmaceuticals. During that period the U.S. Food and Drug Administration (FDA) approved fewer than a dozen drugs derived from plants.

Part of the reason is simply bottom line. The development of a new FDA-approved drug costs as much as 500 million dollars. Manufacturers have found the route from plant to safe, reliable pill difficult and unpredictable, so there is limited incentive to base drug development on plants. Still, almost two-thirds of the Earth's 6.1 billion people rely on the healing power of plants; for them nothing else is affordable or available. And even in industrialized countries where scientifically formulated drugs are readily available—Americans spent 103 billion dollars on retail prescription drugs in 1998—use of nonprescription botanical drugs is rising dramatically. In 1990, 2.5 percent of Americans purchased herbal remedies; in 1997, 12.1 percent spent roughly five billion dollars on them.

What part of that money was spent wisely is a matter of some debate. While many plants have been the subject of extensive study and their effects well documented, data on others are inconclusive. Scientists are often unable to determine which chemical or combination of chemicals within a plant is responsible for relieving pain or stimulating blood flow or creating a feeling of increased well-being. Trying to find the part of a plant that has a specific effect can be like disassembling a radio to search for the one part that makes the sound.

Certain claims—"Guaranteed Better Health: only $5.00!"—in a proliferating number of special interest publications may well be false. No one knows, furthermore, to what extent the placebo effect is at play: Sometimes people want natural remedies to make them feel better, so they take them and feel better whether or not the substance had any effect.

Nonetheless, that plants contain bioactive chemicals, many with beneficial medicinal effects, is undeniable. Arnold Relman, editor in chief emeritus of the *New England Journal of Medicine*, who has attacked various forms of alternative medicine for being based on "irrational or fanciful thinking" or on theories that "violate basic scientific principles," says that therapy based on botanical products need not be in fundamental conflict with mainstream



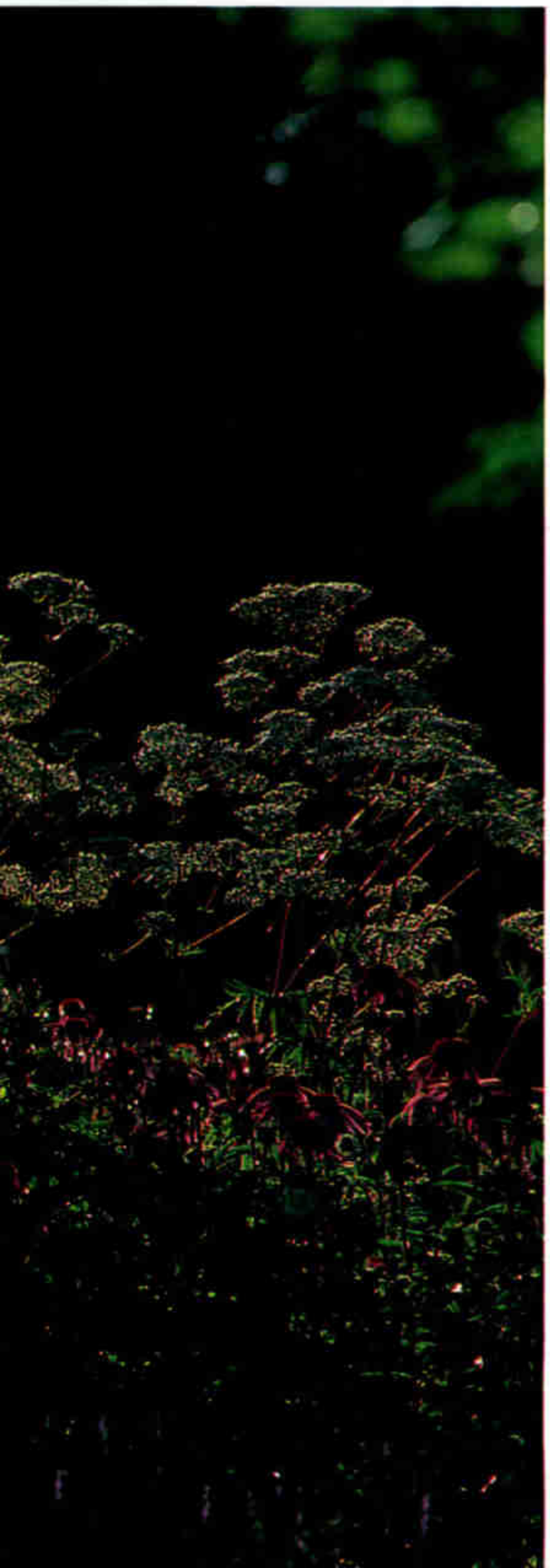
Childhood Leukemia

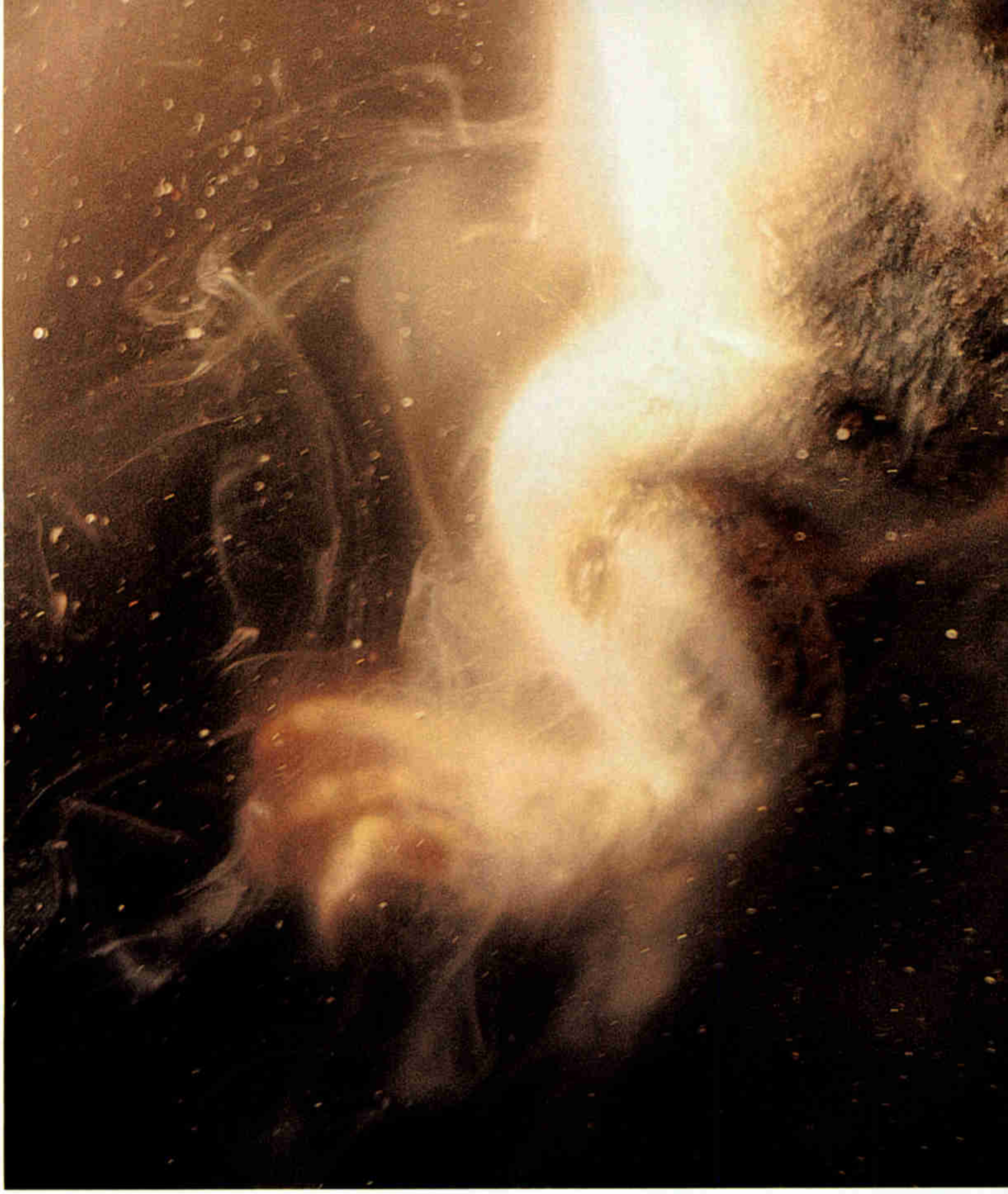
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Rosy Periwinkle

CATHARANTHUS ROSEUS

HEATHER R. HOFFMAN, NGS STAFF

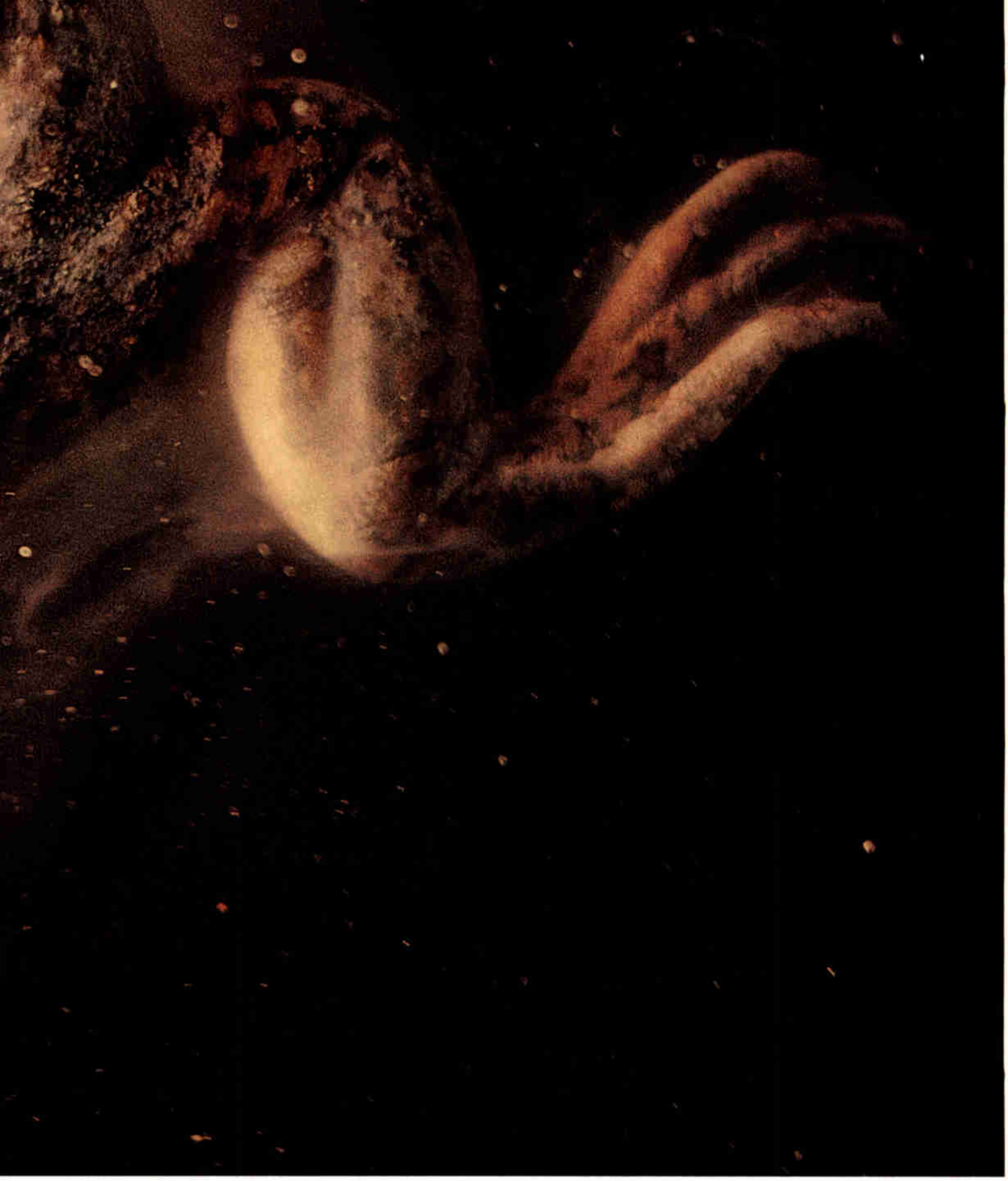




medicine. "Many plant-derived materials," says Relman, "have been proved to have important biological effects."

Relman insists on scientific testing before he'll believe in an herbal remedy, but people use hundreds of plants, not all of which have been tested by science, to combat ailments ranging from cancer to colds. Echinacea, an herb taken in tablet or liquid form, activates phagocytes—white blood cells that ingest bacteria and viruses. It can be effective in fighting flu, herpes, and yeast infections. Garlic contains allicin, a chemical that has antibiotic and antifungal effects, as well as compounds that

Photographer LYNN JOHNSON's last assignment for the magazine was "Vincent van Gogh" in the October 1997 issue. Johnson worked with Joel Swerdlow on the National Geographic book *Nature's Medicine: Plants That Heal*, due out next month.



can lower cholesterol and combat hypertension. Ginger contains at least 10 antiviral compounds, and studies have shown that it reduces vertigo and motion sickness. Chemicals in goldenseal, an herb of the buttercup family, kill certain bacteria, fungi, and protozoans.

ROSY PERIWINKLE, the plant so important in Audra's leukemia treatments, is one of more than 10,000 known plant species in Madagascar, a Texas-size island off the coast of southeast Africa. Many of these species originally were found nowhere else in the world. A huge array of them, I discovered, is available for sale on any morning at the outdoor market in Antananarivo, Madagascar's capital.

I arrived at the market at 6:30 a.m. In an area roughly the size of two

SKIN CREAM

Dosed with adrenaline in a lab, an African clawed frog emits a milky cloud containing magainins, antibiotics that protect its skin from infection. A cream derived from magainins may one day be used on foot ulcers in diabetics.



ACTIVE INGREDIENTS

Braving bee stings (above), a man with arthritis in Vermont gets a megadose of the body's natural steroids as they rush to the site of the sting. In a Maine pond (facing page) Avena Botanicals' Deborah Keene-Jones hunts for white pond lily roots, used in a tincture for cervicitis. Meanwhile, the search for nature's prize remedy—for cancer—goes on round-the-clock at the National Cancer Institute (below).

city blocks were hundreds of straw mats, on tables and on the ground, piled with sticks, leaves, grasses, bark, wood chips, oils, seeds, and nuts. White clay bowls held red, yellow, and orange berries. Three-inch segments of hollow bamboo stalk served as bottles for medicinal oils. Branches and stalks were tied in bundles. Vendors shaved sticks with hacksaws and wrapped the shavings in paper or banana leaves to sell.

My companion, Nat Quansah, an ethnobotanist from Ghana who lives in Madagascar and has studied medicinal plants there for nearly two decades, explained that the vendors in the marketplace represent the local population's main medical resource, functioning not only as salespeople but also as doctors and pharmacists. Their knowledge comes from experience, from trial and error with plant remedies, from methods passed down from generation to generation. Their advice—expert or not—might mean the difference between life and death. I learned from one that a plant used to correct hypertension becomes, in stronger dosages, a poison that people use to commit suicide.

As we walked from table to table, I always inquired about rosy periwinkle. The vendors suggested a wide range of uses. Quansah explained that pharmaceutical researchers first became interested in it because people in the Philippines and the Caribbean use a home-brewed periwinkle tea to treat diabetes. Like many plants, it can lower blood sugar. But its strong anticancer properties came as a surprise to researchers.

IN THE MADAGASCAN COUNTRYSIDE people who need medication consult an *ombiasy,* or healer, with a special connection to plants and knowledge of sacred artifacts used to invoke their healing power. We visited the home of one such healer, four small rooms with dirt floors. Seated on wooden benches in the waiting area, we watched patient after patient leave with hands full of plants—one with the greenish *Jateorhiza palmata* vine to deaden pain, another with the leaves



and bark of *Harungana madagascariensis,* which stimulate gastric juice secretion, useful in the treatment of digestive disorders. Scientists have documented the effects of both these plants.

I asked the healer where her medicines came from, expecting her to say that a lack of money prevented her from buying all the necessary medicinal plants. Instead she waved her hand in a sweeping motion. Quansah explained: "She just walks out of her house and picks whatever plants she needs."

How much longer will she be able to do that, I wondered as we continued our drive across the island. Along the road that connects east and west Madagascar—potholed and in some places washed away—we encountered mile after mile of broken, smoldering trees, where slash-and-burn farming, fueled by population pressures, has left much of the land bare. Streams flowed dark red with soil runoff. Of Madagascar's thousands of plant species, Quansah said, a great number are in danger of extinction. "What once was a rain forest is now a rain desert," one local man told me. "This place was very beautiful when I was a child. It was a forest filled with lemurs."

"Stop the car!" I shouted. Thinking of all the potential cures for cancer and other diseases being lost, I traced an "X" in the middle of the road and asked Quansah to stand on it. Not hiding that I was upset, I asked him to stand there until he could see a medicinal plant that grows only in Madagascar.

He examined the bushes and scrub trees on either side of the road and pointed to a vine hanging 20 feet away: "That purple flower there."

As we walked toward it, he began to show me other medicinal plants we passed along the way. We hadn't left the road when he stopped and touched a tall leafless stem that, crushed and brewed into a tea, acts

Ovarian Cancer

℞

Pacific Yew

TAXUS BREVIFOLIA



HEATHER R. HOFFMAN



Medicine for the Mind

Torment subsides for a patient in an Indian psychiatric hospital as a poultice of herbs wrapped in banana leaves slowly takes effect. Reporting high success rates, doctors of Ayurvedic medicine use such techniques to help relieve stress and anxiety.

as an anesthetic. Chemicals in the leaves of another bush, he said, kill a certain virus. More than an hour later we still hadn't reached the purple flowers. Every step of the way, Quansah showed me more medicinal plants.

In *Romeo and Juliet* William Shakespeare describes "the powerful grace that lies in herbs." It was becoming clear to me that plants' powerful arsenal of bioactive substances—compounds that affect living cells—can be of significant value in waging war against human ailments.

MY GROWING FAITH IN PLANT POWER was soon tested. Traveling with Quansah and me in Madagascar was Gerry Bodeker, founder of the Global Initiative For Traditional Systems of Health, based at Oxford University. "I think I'm getting sick," Bodeker said one morning.

He had a high fever, and I offered antibiotics. Bodeker refused, insisting that Quansah and I get what the local healer recommended. Preparing a batch of leaves according to her instructions, we gave Bodeker a tea to sip, then boiled another brew and bent him over the pot with a towel draped over his head so he could inhale the steam.

The next morning Bodeker was fine. Whether the herbs did any good was impossible to know. On our trip I also saw plenty of people whose high fevers did not respond to plant treatments. In one rural hospital most of the beds, dirty foam mattresses on wood frames, were occupied by children with malaria, a disease that afflicts at least 300 million people worldwide and kills more than a million each year. Staring at the ceiling, the children endured fever, headache, vomiting, and stomach pain. Many would eventually suffer convulsions, unconsciousness, coma, and, finally, death.

"We give chloroquine until our supply runs out, then we can do little for them," the hospital's only doctor told me. "The parasite takes over the red blood cells." He explained that synthetically manufactured chloroquine, the only antimalarial drug the doctor had, is often useless because the parasite can develop resistance to it.



THE ESSENCE OF HEALTH

Drop by precious drop, workers at Poonkutil Mana Hospital in Kerala, India, squeeze juice from brahmi, *or water hyssop. Mixed with other plants and melted butter, the extract is used to treat mental illnesses. Brahmi is also used in* kaya-kalpa vati *(left), rejuvenating pills given to patients with degenerative diseases at a New Delhi clinic.*

A two-minute drive from the hospital brought us to a source of such resistance. To kill parasites that are sensitive to chloroquine, a patient must take 15 pills over three days. Yet vendors at roadside stands were selling chloroquine pills one at a time—no doctors or prescriptions involved—at a price equal to much of what a manual laborer would make in a day. Many people favor the pills over traditional remedies because their effect can be quick and dramatic. But after only a few doses most people either run out of money or feel better, and stop. After the pattern repeats a few times, their bodies become factories for drug-resistant parasites.

"Despite the popularity of Western medicines, rural people throughout Africa and Asia still rely on plant remedies to combat malaria," said Philippe Rasoanaivo, chief scientist at the Institut Malgache de Recherches Appliquées back in Antananarivo. His research has isolated several plants that combat parasites. Some interfere with the parasite's DNA; others stimulate the oxygen-burning action of cells, releasing oxidants that can kill the parasites.

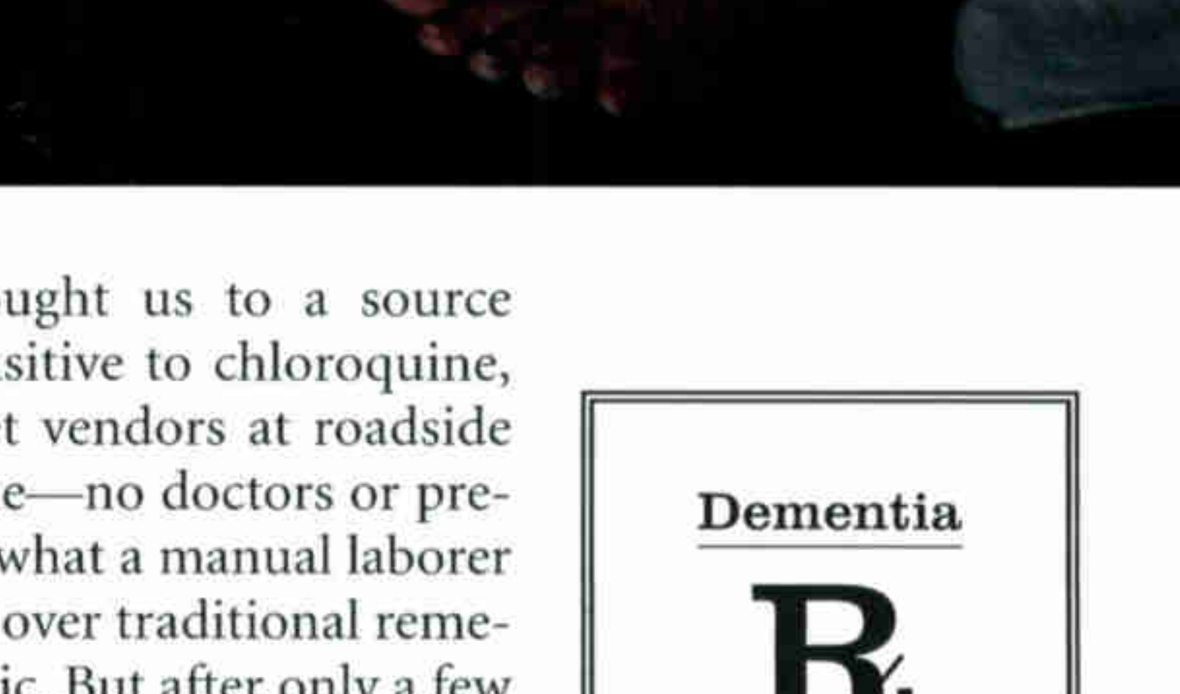
Rasoanaivo, who almost died of malaria at 13, has developed a tea that shows great promise. "It has dried stem barks of *Strychnos*

Dementia

℞

Ginkgo

GINKGO
BILOBA



myrtoides," he said, handing me some chloroquine pills. "Patients take these pills and drink the infusion of the tea bag. The bark enhances the action of chloroquine against resistant parasites."

When we met, Rasoanaivo was in the process of planning clinical trials that he hoped would persuade a Western pharmaceutical company to test and manufacture chloroquine combined with the resistance-fighting plant he had put into his tea bag. But he knew the implementation of his plan would not be simple. He told me a story that made clear why it is so difficult to turn Madagascan plants into Western pharmaceuticals.

Several years earlier a local healer in southern Madagascar had given Rasoanaivo an unnamed plant that subsequently showed strong anticancer effects in laboratory tests. He went back for more of the plant, but the new batch demonstrated no anticancer activity. "Some plant species have several subspecies or varieties, many of which we haven't yet identified," Rasoanaivo explained. "In addition, for the plant parts you pick to have the same chemical composition, you have to know exactly *when* to pick them. Chemical composition can vary from morning to night. Also, is the plant old or young? What is growing nearby?

"A typical plant, furthermore, has a large number of active molecules," Rasoanaivo continued. "Chemicals act and react with each other, sometimes augmenting, sometimes decreasing the impact on human cells. Modern scientists, to make a medicine, need a single active compound. They need to know exactly what is active in the medicine so it can be standardized, measured, and checked for toxicity."

IN INDIA, A HEALING SYSTEM known as Ayurveda goes back several thousand years. Practitioners of Ayurveda employ nearly 2,000 cultivated and wild plant species from throughout the Indian subcontinent. The system does not focus on medicines that kill disease-causing microbes but rather operates according to the view that good health results from "maintaining the body's equilibrium," said Vijay Kinra, medical director at the Khosla Hospital, an Ayurvedic facility in Delhi. "Most natural is not to fight disease but to maintain health and prevent illness," he said. I asked him how he fights malaria, which is endemic in India.

"The treatment does not kill the parasite," he replied. "The treatment seeks to restore the body's balance."

This seemed crazy to me. Malaria protozoans take over a person's red blood cells. Why wouldn't you try to kill them?

In fact, although many children die of malaria in India, many adults live with the disease, developing an immunity and becoming sick only periodically. "In Western medicine you attack the parasite," said Kinra. "But we build our approach on the knowledge that lots of potentially harmful things live in the human body all the time. Lots of people are exposed to malaria and never get sick. We use plants to make the body strong and to boost its ability to live with the malaria parasite."

Remembering the children dying of malaria in Madagascar, I still wanted to kill the parasite. But I could see that other possibilities exist.

"You've only seen the beginning," Darshan Shankar told me. He's the founder and director of the Foundation for Revitalization of Local Health Traditions, a program striving to conserve medicinal plants and related cultural traditions in India.

I went with Shankar through the herb garden in the village of

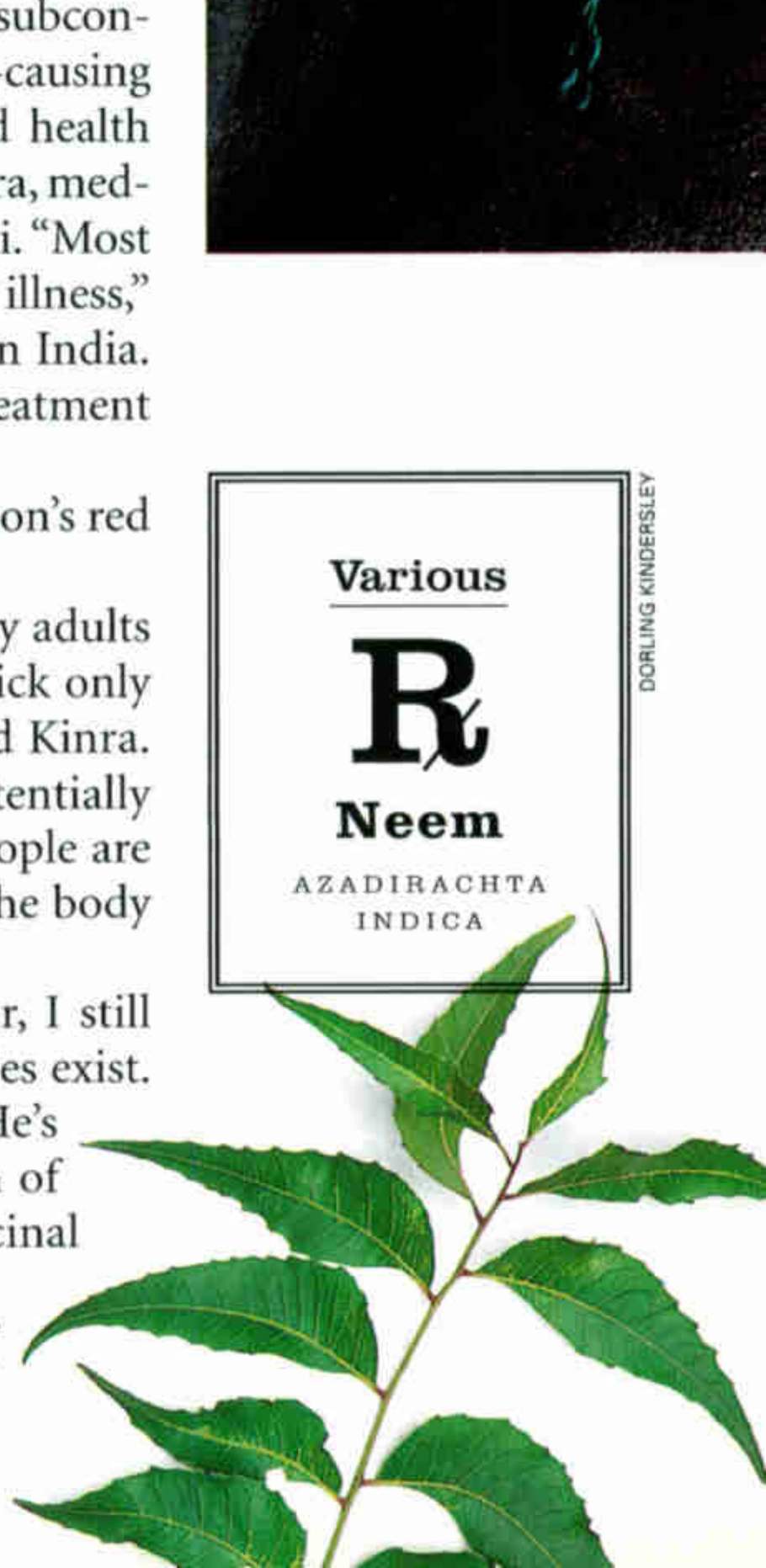


Various

Rx

Neem

AZADIRACHTA INDICA



DORLING KINDERSLEY



Jodagette, near Bangalore, where local healers rely on unwritten folk knowledge. We met three healers, all specialists—one treated burns, another snakebites, another skin conditions. The last healer broke open a plant stem and smeared the sticky white sap, which has an antibiotic effect, on my forearm. "We must honor this plant as we honor a blood bank," he said.

"Valuing and preserving the knowledge of these healers is as important as valuing and preserving the plants," Shankar told me. "The world has realized it should be concerned about saving biodiversity. But cultural knowledge is just as important. Destroy the local knowledge system and thousands of years of time-tested data are gone."

In Jodagette many villagers encounter deadly snakes, particularly during the monsoon season, when rice is sown. G. Swami Rao, who treats the villagers' snakebites, showed me how he grinds his plants into a paste. It's the only treatment for cobra bites available here. Antivenom, made with horse antibodies, is too expensive for the village to keep on hand, and it must be administered as soon as possible. The nearest hospital is about three hours away by car, and no one in Jodagette has a car.

Villager after villager told me how swallowing Rao's remedy after

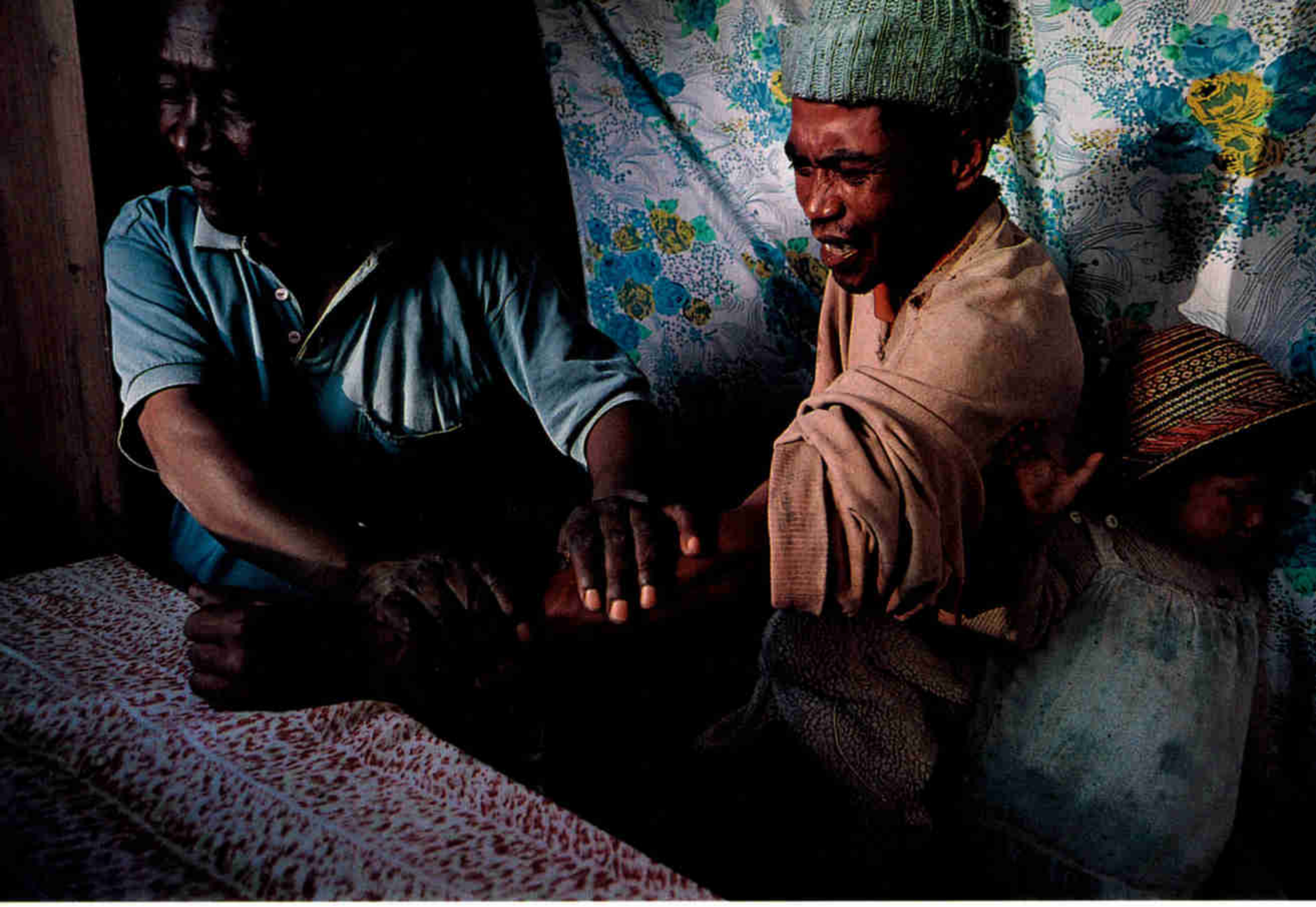
BODY CAST

Chest deep in sand, a seven-year-old cerebral palsy patient undergoes therapy at a Tamil Nadu, India, orthopedic hospital. After an herbal oil massage to soften the bones, doctors here use such methods—which they claim result in up to 75 percent improvement—to realign and fortify his lower back and limbs.



Chipping Away at Pain

Boiled down to a broth, the bark of Madagascar's baobab tree relieves back pain. Because the baobab is held sacred, sufferers cut only as much bark as they need.



MALARIA MASSAGE

Too poor to buy chloroquine, a malaria patient in Madagascar visits healer Pierre Rakotondramaro, who treats patients with herbs and massage. Some 10,000 Malagasy die of malaria each year. At Moramanga Malaria Hospital (facing page) a family tends to the body of a dead child—their second to die of the disease.

a snakebite had saved a friend or family member. Although they may have survived without any treatment, it is possible that molecules in Rao's plants chemically interact with components of the snake venom, or they may stimulate a helpful reaction such as an immune response or a rise in blood pressure.

When I visited Calcutta, I asked Antony Gomes, a Western-trained professor of physiology at the University of Calcutta, about Rao's plants. Why couldn't such a treatment be recorded and standardized? His answer reminded me of what Philippe Rasoanaivo had said about the plant in Madagascar that had shown anticancer effects.

Gomes told me how, a year earlier, he had visited a healer in rural West Bengal whose plant successfully countered cobra and viper poison. The healer's recipe had come from his grandfather to his father to him.

Gomes took the healer's plant to his laboratory to test on rats. He prepared a dosage of snake venom that he could predict would kill 50 percent of the animals. He administered it by injection, and 50 percent of the rats died. Next, he gave the same dosage to another group of rats, then fed them an extract of the roots. None of the rats died.

Gomes returned for more of the plants, but the healer had grown suspicious and refused to provide any more.

So Gomes had a botanist examine what remained of the first batch of plants. Together they went to rural West Bengal, collected the same plant, and again tried the experiment. The new plants did nothing to neutralize the venom. Just as Rasoanaivo had found in his work with anticancer medicines, the chemical composition of plants is complicated. Even with all their modern technology scientists do not know which plants to pick or when to pick them or whether traditional healers might have added other herbal or nonherbal ingredients to the cure.

Gomes's story was another illustration of why pharmaceutical companies spend an insignificant amount of their research money on natural products and why they focus most of their resources on genetic research and synthetic drug design: Understand the pathological process that causes disease, and design a molecule that fixes it.



THIS ISN'T TO SAY that researchers have given up trying to produce effective pharmaceuticals from plants. In 1976 Baruch Blumberg won the Nobel Prize in medicine for his work on infectious viral diseases. Among his accomplishments was the discovery of an antigen, or a marker, on the surface of the hepatitis B virus cell. This discovery led to the development of a hepatitis vaccine.

Blumberg's vaccine is produced synthetically, but he and his team, hoping to treat people who had already contracted hepatitis B, later studied hundreds of plants used by traditional healers worldwide to fight jaundice, a symptom of the disease. They extracted chemicals from *Phyllanthus amarus,* a mainstay of India's Ayurvedic medicine. In laboratory and animal tests, these chemicals acted on the hepatitis B virus, disrupting its development—a result repeated in a clinical trial on patients in India.

When other researchers repeated the experiment, however, their findings were inconclusive. The plant's effectiveness varied, apparently, depending on where it grew and when it was picked. I asked Blumberg if he believed that it was impossible for modern medicine to develop reliable pharmaceuticals from plants.

"No," he replied. "The lesson is that we need a better way to deal with all the variables involved. We need a new way to listen to nature while maintaining all the advantages of science. Certainly science should be open to this. By definition science welcomes new evidence, new ways of thinking. It has no final truths. It is a continuous quest and exploration."



Nature's Medicine in Action

Photographer Lynn Johnson's account of a burn victim's amazing recovery

I had been photographing at Manongarivo clinic in Madagascar, documenting the rural facility's unique blend of traditional and Western medicine. But it took an emergency to show me how effective this collaboration can be.

It began with spine-chilling screams, as a villager rushed in with her badly burned child, a toddler named Natacha. The girl had been playing outside the door, the mother explained, and she had accidentally tossed a pot of scalding water on her.

Dr. Jean Berthin Tida, a Western-trained physician, examined the girl's blistered abdomen and diagnosed the burns as third degree. He then conferred with the clinic's traditional healer, an herbalist named Ndronalahy, who after examining the burns left to collect a plant from the forest. Even in the most sterile, modern facilities, children with such burns often do not survive. I wondered if Natacha would make it.



NAT OUANSAH

Soon Ndronalahy returned with a length of liana. He blew into one end, forcing sap from the other (above). As it coated the child's burns, her crying suddenly stopped. Ndronalahy later scraped the skin off a calabash, mixed it with water, and dabbed the liquid on her flesh. Given daily treatments of this mixture, Natacha was completely healed a month later (inset)—a triumph for her, and for the curative powers of nature.

One of the world's leaders in the quest is Jim Duke, a botanist who recently retired from the U.S. Department of Agriculture after three decades of studying medicinal plants. He's the author of *The Green Pharmacy* and *Herbs of the Bible: 2000 Years of Plant Medicine.*

In Duke's medicinal garden in rural Maryland hundreds of plants carpet a hillside sloping down to a creek. Some of the plants are more than ten feet tall, others crawl along the ground; some are brightly colored, others drab. Bees and butterflies, along with the scents of apple, licorice, and mint, fill the air.

As Duke described the plants, I realized that untapped plant power abounds everywhere. Seeds of the milk thistle, a weed that grows in many backyards, contain silymarin, a compound that helps prevent toxins from entering the human liver.

"Come down to the catacomb," Duke said, leading me into his book-filled basement. "I wish we could get the spiritual connection to plants that shamans have," said Duke, "but in some ways we know a lot more. We have studies and evidence. Not romantic views of how nature works but hard facts."

As we flipped through his computerized data bank, Duke talked about how isoflavones in soybeans may fight breast cancer; how angelica contains compounds that cause smooth-muscle cell walls to relax, reducing chest pain, or angina, caused by atherosclerosis; and how the kava rhizome contains compounds used as numbing agents or as sedatives.

One of Duke's missions is to gather data to help overcome the resistance to plant remedies. I told him about a woman who suffers from severe arthritis. The medicine she takes for pain causes bleeding and shortness of breath. A friend suggested various botanicals, but the woman refused to try plants or herbs. "They're not scientific or medical," she said. She wanted a pill.



Duke pointed out that if a little white pill could significantly cut chances of developing cancer, having a heart attack, or suffering from a stroke, people would take it, especially if it had no side effects. In fact, he said, this "pill" already exists. It's called "eating fruits and vegetables every day." Scientists have started to identify the antioxidants, detoxifiers, hormone regulators, and other substances in food that cut the risk of various diseases.

"We can merge science with herbalism," Duke said. "This will give us better drugs than if we rely on manufactured drugs alone. We can use science to test plants, to find what works best. The issue is not nature versus science; rather it is how to use science to get the best medicine, be it natural or synthetic.

"My life's ambition," said Duke, "is to get the FDA to require drug companies to test their new synthetic drugs not only against inactive substances, or placebos, but also against any known or suspected herbal alternative. We can have what plants offer without leaving the scientific method."

Back in Duke's garden I spotted what appeared to be a common weed and bent to pull it up. "Please don't," Duke said. The plant was chicory, which contains chicoric acid—a chemical that shows promising activity against the virus associated with AIDS. □

Can science further benefit from the study of medicines in nature? Comment online at *www.nationalgeographic.com/ngm/0004.*

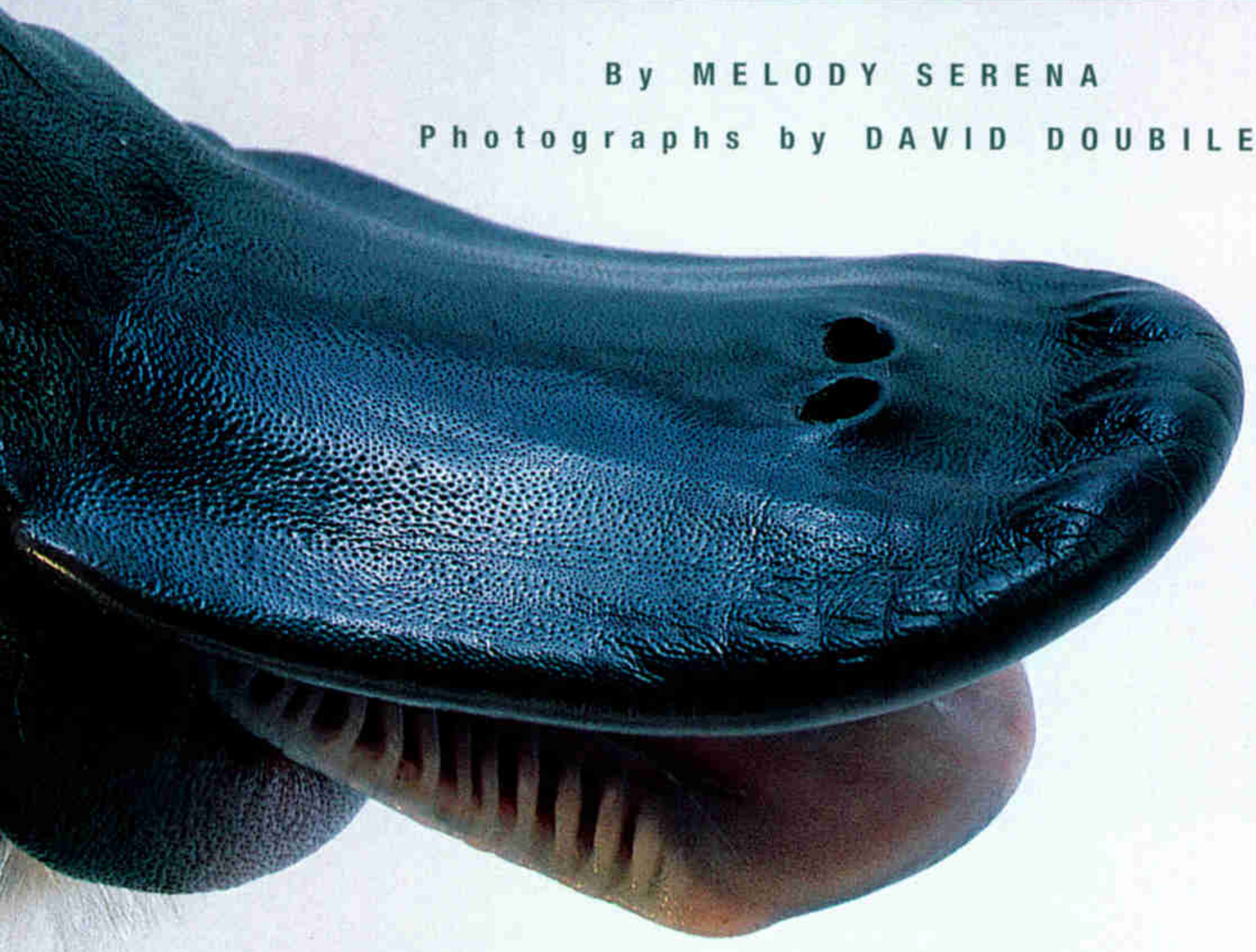


Duck-billed Platypus

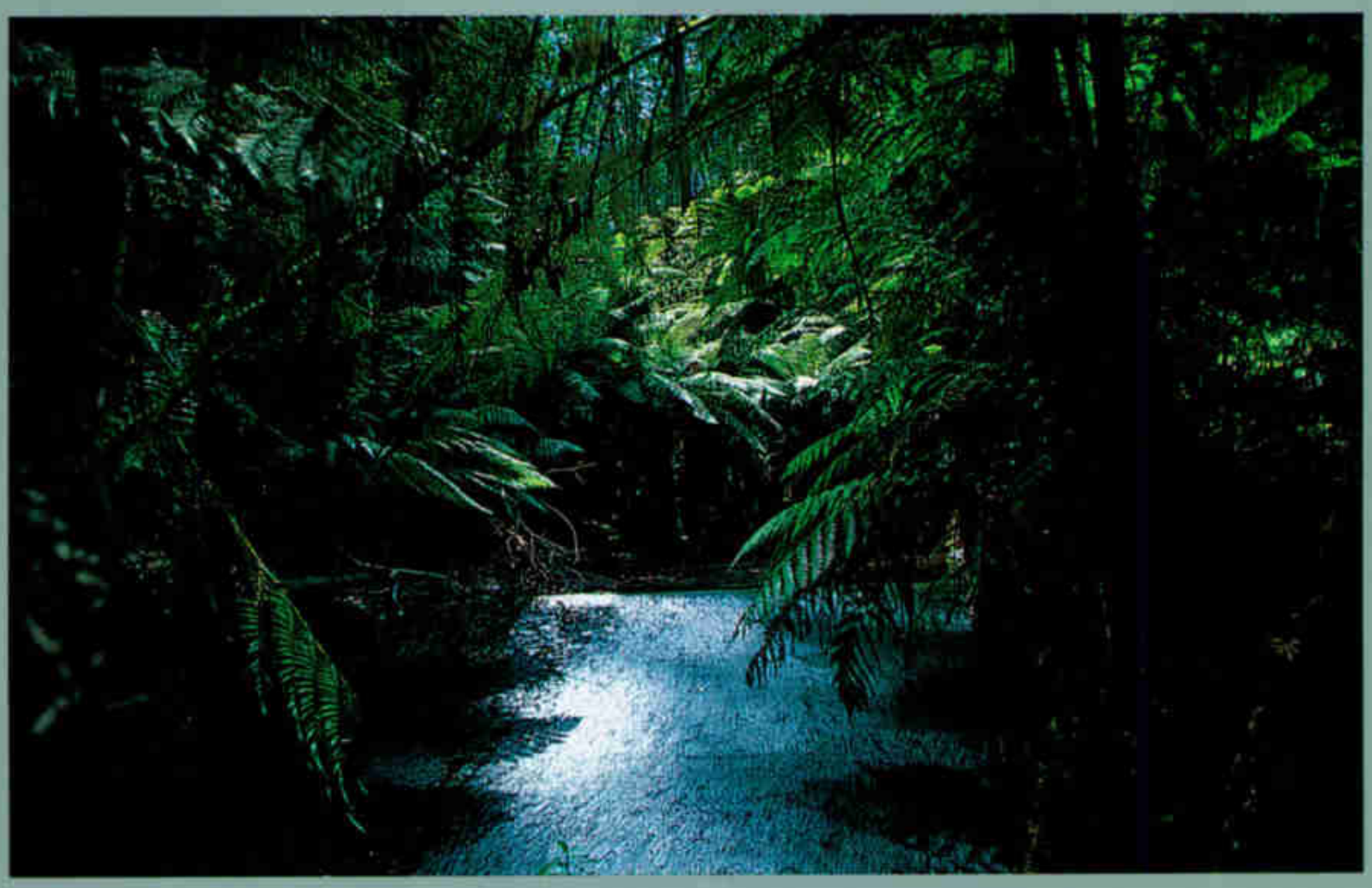
AUSTRALIA'S URBAN ODDITY

By MELODY SERENA

Photographs by DAVID DOUBILET



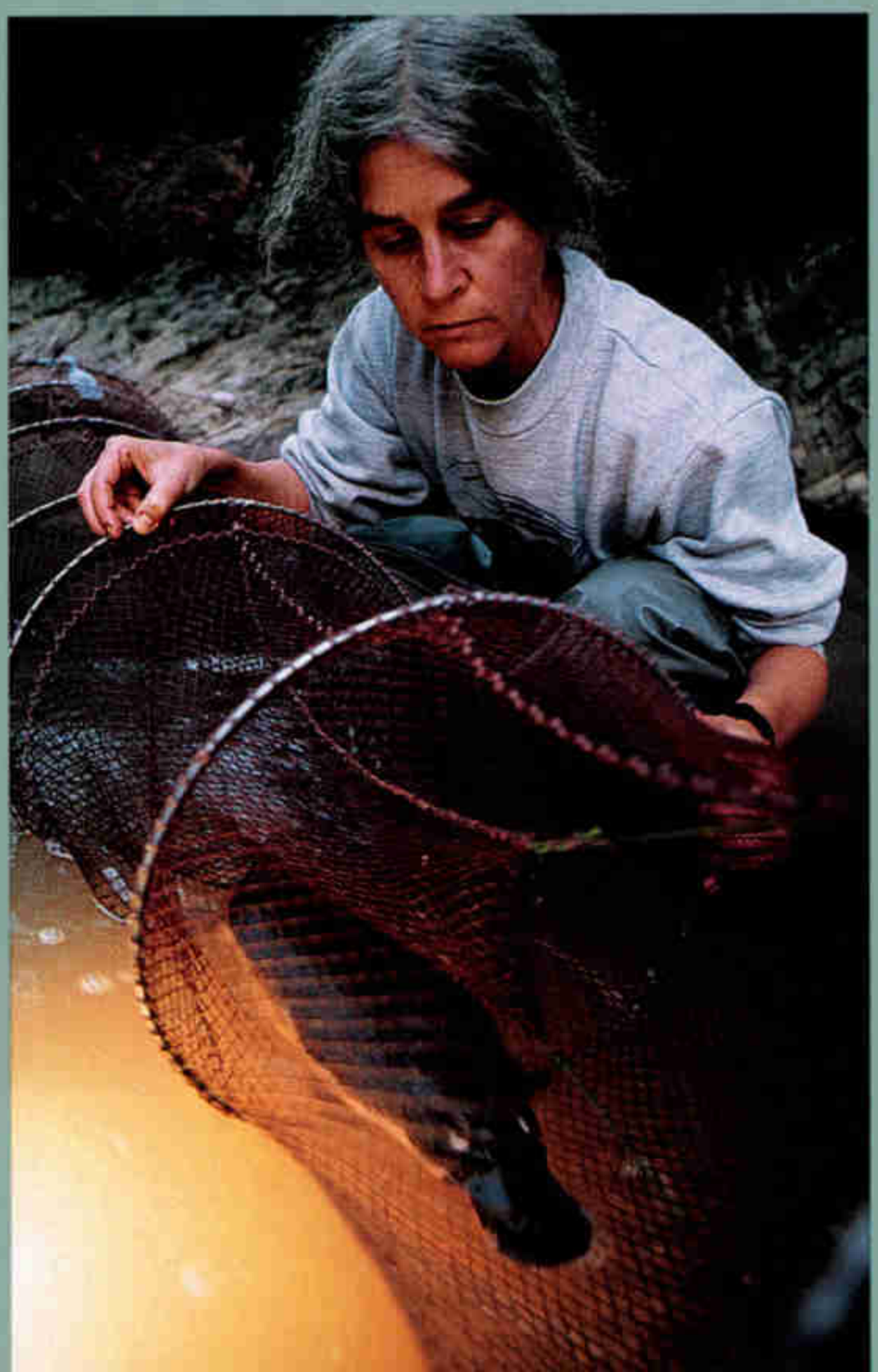
The first platypus swam around the feet of the dinosaurs more than a hundred million years ago. But can this surprising animal adapt to modern city life? Scientific research along Melbourne's waterways is providing new insights into the furry egg-laying mammal with a lizard-like gait—one of Australia's most bizarre and elusive creatures.



Spending nearly all its life underwater or underground, the duck-billed platypus, *Ornithorhynchus anatinus,* does not easily share its secrets. Along lushly forested stream banks (above), ferns and shrubs disguise entrances to burrows where the animal sleeps during the day.

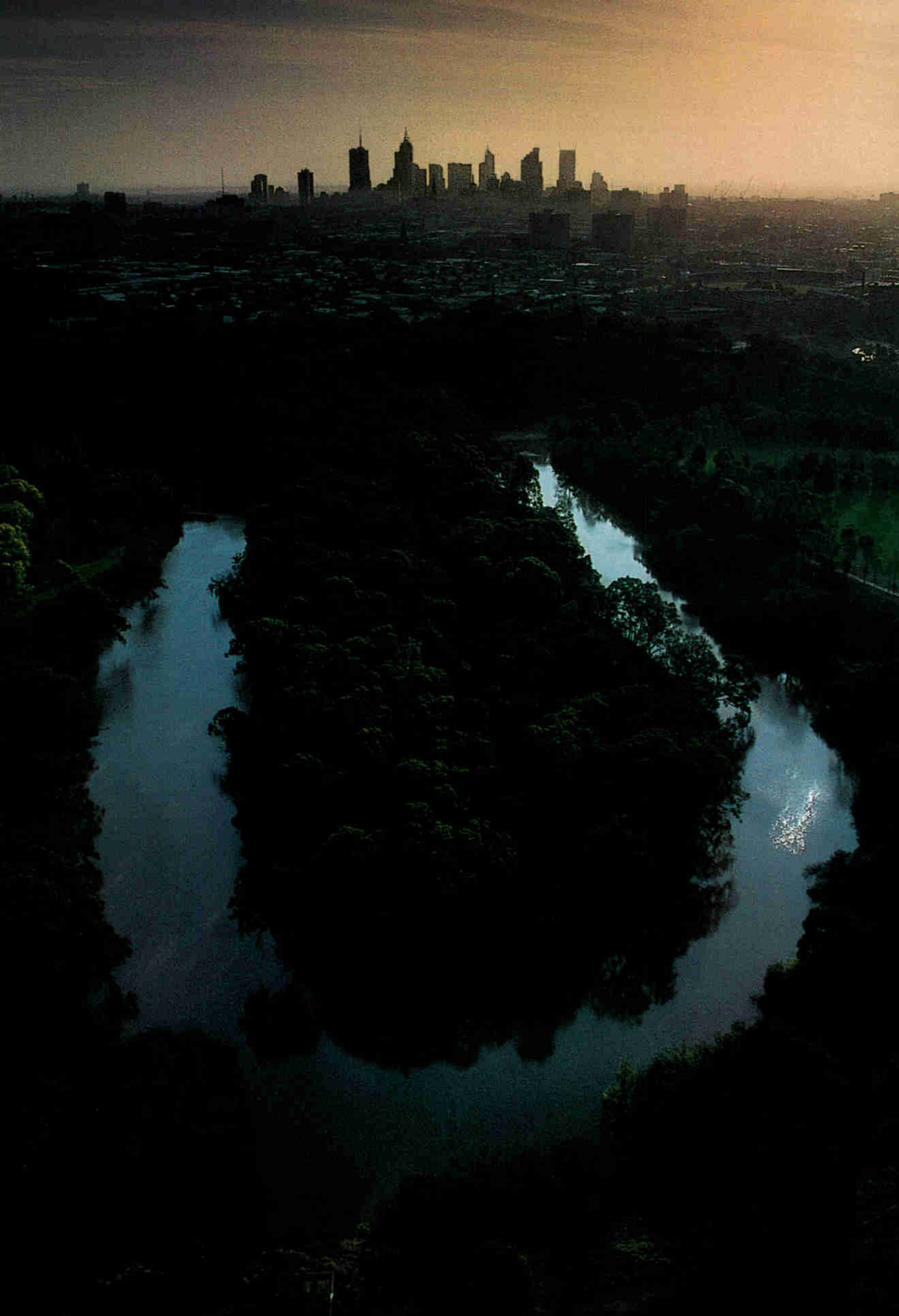
The setting sun marks the start of the platypus workday along the Yarra River east of Melbourne (facing page), where adults travel up to four miles on their nightly hunt. Using oral grinding pads rather than true teeth to eat their prey, they dive industriously for crayfish, horsehair worms, freshwater shrimps, and aquatic insects such as larval dragonflies. Weighing between one and a half and six pounds, an adult consumes up to 30 percent of its weight in food each day to fuel its active, aquatic lifestyle. But because the animals feed only in the water, they rarely leave traces such as tracks, food scraps, or scats. Quiet and retiring, platypuses are easily startled by a movement on the bank. And just for good measure, they don't congregate or call to each other.

My challenge begins in the afternoon, when I place survey nets along some 12 miles of waterway; through the night I visit nets hourly to reduce risk to the animals.



After splashing through a stream to check a net, I'm pleased to see the double curve of a bill and two telltale facial spots (left). Before releasing the platypus, I will weigh and measure it and implant a microchip so it can be identified if recaptured later. By dawn I am exhausted yet exhilarated: I have netted ten animals for my study.

MELODY SERENA is a conservation biologist for the Australian Platypus Conservancy. DAVID DOUBILET also photographed sharks for this issue.



RESEARCH PROJECT

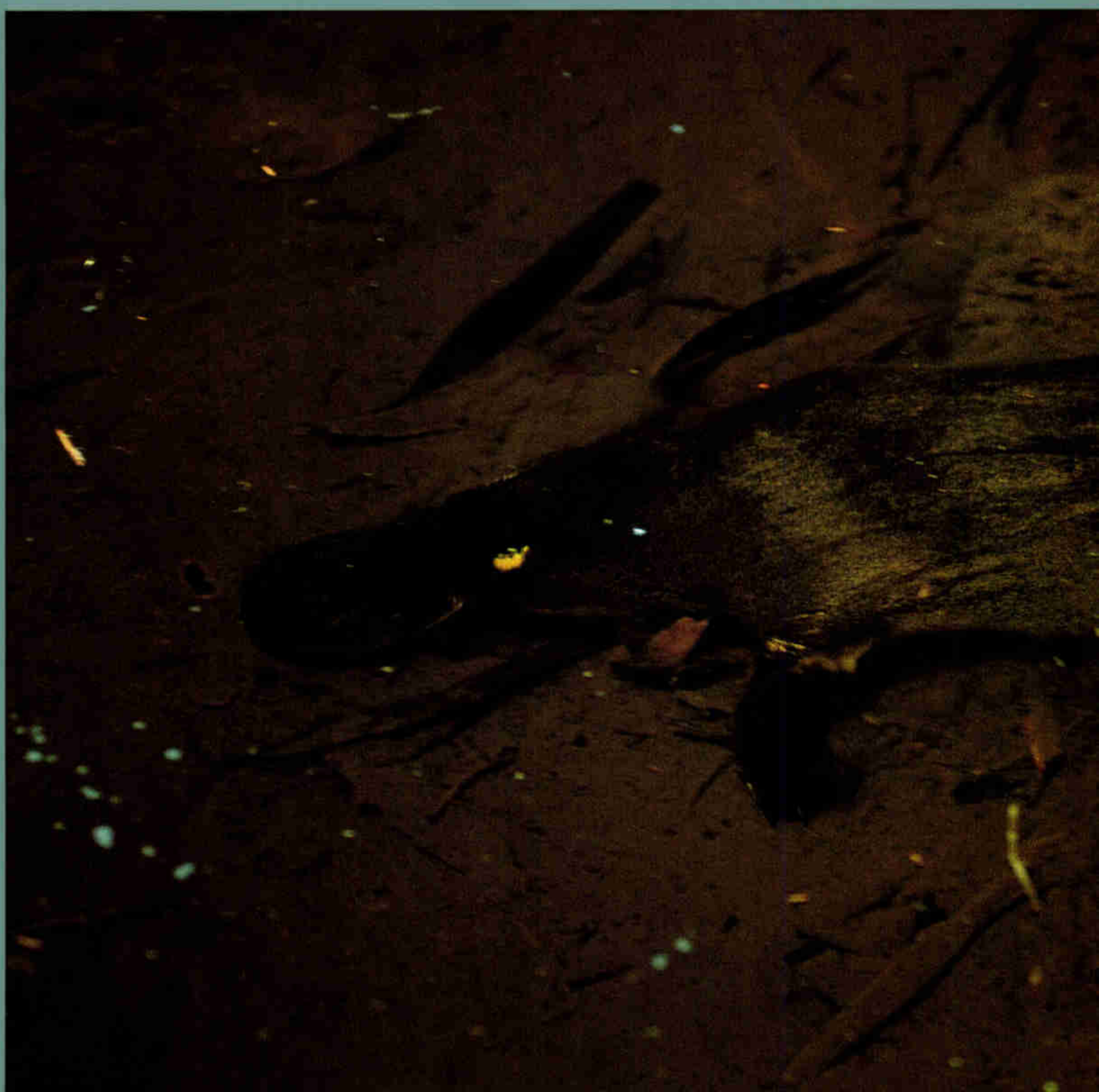
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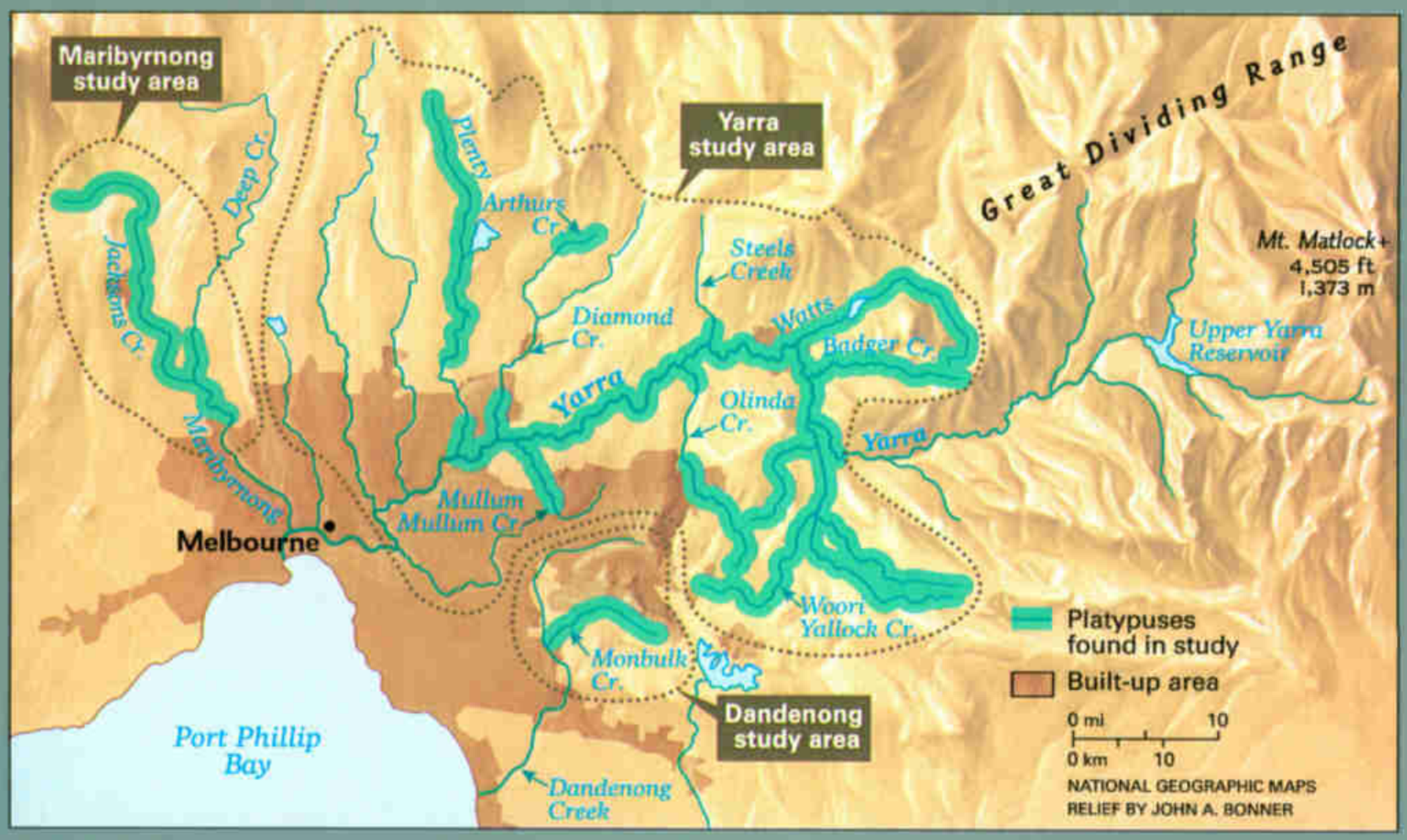
Prowling over a streambed, a platypus hunts with eyes and ears closed, using touch and electroreceptors in its bill to detect the movement of prey. (Flecks in the water reflect the photographer's strobe.)

Skeptics scoffed when I began searching for platypuses around Melbourne. Most Australians have never seen one in the wild, so they assume the species is found only in remote parts of its range in Tasmania and mainland eastern Australia. Yet I found platypuses in half the waterways of greater Melbourne—home to 3.3 million people—including the Yarra River within ten miles of downtown. Although I've trapped and released nearly 300 platypuses around the city in the past five years, there are certainly fewer animals today than when Melbourne was founded in 1835.



The city's water department is improving urban platypus habitat by repairing eroded stream channels and publicizing the hazards of litter. But the platypus's future in Melbourne and other cities is ultimately in the hands of the residents. Debris such as six-pack holders and fishing line is tangled around 10 percent of the animals I find in urban areas. When it cuts them or shackles their legs, they can die.




Maribyrnong study area
Yarra study area
Great Dividing Range
Deep Cr.
Plenty
Arthurs Cr.
Steels Creek
Mt. Matlock+
4,505 ft
1,373 m
Jacksons Cr.
Diamond Cr.
Watts
Badger Cr.
Upper Yarra Reservoir
Yarra
Olinda Cr.
Yarra
Maribyrnong
Mullum Mullum Cr.
Melbourne
Woori Yallock Cr.
Monbulk Cr.
Dandenong study area
Port Phillip Bay
Dandenong Creek
Platypuses found in study
Built-up area
0 mi 10
0 km 10
NATIONAL GEOGRAPHIC MAPS
RELIEF BY JOHN A. BONNER



Briefly stretching, a mother reveals her eggs before resuming a tightly curled brooding position in her burrow. Breeding females lay a clutch of one to three eggs in the spring. Young hatch in about ten days and suckle until they are around 16 weeks old.

The Watery World of the Platypus

An ever ravenous platypus scans a stream bottom for morsels as another sets out from its burrow for the evening hunt. Entrances to platypus homes are often hidden beneath undercut banks or just below the water's surface. Excavations known as camping burrows (1) provide shelter for males and non-lactating females and are usually a few feet from water's edge. Nesting burrows (2) house mothers and dependent offspring and extend as much as a hundred feet from the water. To protect their young from flooding and predators such as carpet pythons, mothers block entry tunnels with soil plugs (3), which they dig through and then carefully rebuild whenever entering or leaving the burrow.

ART BY JOHN D. DAWSON


3
1

Melbourne veterinarian Ted Donelan and nurse Wendy Wadsworth monitor the heart rate of a lightly anesthetized male. The animal will be checked for signs of injury and disease.

Unique among mammals, adult males have a sharp venom-secreting spur on each ankle (right and bottom left), which is probably used to compete for mates in the spring breeding season. Being spurred is not life-threatening for humans but can trigger severe pain and swelling.

Museum Victoria preserves rarely seen platypus eggs (bottom right) and a streamlined, sturdy skeleton, here superimposed over a stuffed specimen in a double exposure (facing page).





Stranded on an island continent, the platypus is a survivor that has adapted to urban surroundings—though it's considered vulnerable to environmental stress. With luck, and some human help, it should endure as a distinctive member of Australia's remarkable menagerie. □





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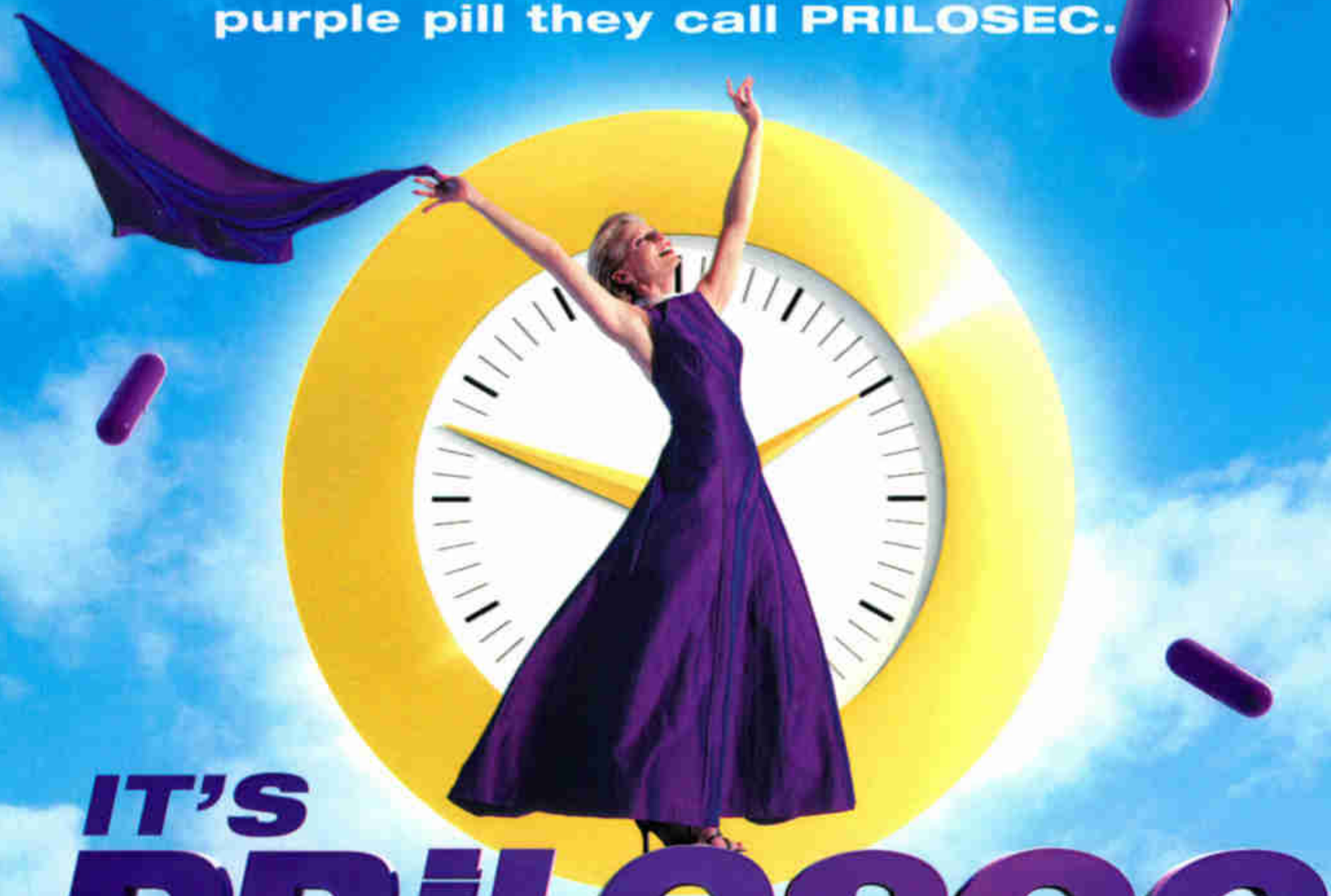
Killer Hat

A masked dancer from the Elema people of Papua balances a shark-effigy headdress crafted from bark cloth and cane. Maskmaking was part of the region's *hevehe* ritual, in which villagers invoked spirits of totem animals during the building of a new men's meetinghouse. These houses were frequented not only by bachelors but also by married men, who retreated there "at intervals, for the sake of a little peace and quiet," noted author E. W. Brandes in his September 1929 article, "Into Primeval Papua by Seaplane."

This photograph, acquired by the GEOGRAPHIC in 1938, has never before been published in the magazine.

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Prilosec®* *(omeprazole)*

Delayed-Release Capsules

BRIEF SUMMARY. Before prescribing, please consult full Prescribing Information.

CLINICAL PHARMACOLOGY, Pharmacokinetics and Metabolism: Omeprazole In pharmacokinetic studies of single 20 mg omeprazole doses, an increase in AUC of approximately four-fold was noted in Asian subjects compared to Caucasians. Dose adjustment, particularly where maintenance of healing of erosive esophagitis is indicated, for the hepatically impaired and Asian subjects should be considered.

INDICATIONS AND USAGE, Duodenal Ulcer: PRILOSEC is indicated for short-term treatment of active duodenal ulcer. Most patients heal within 4 weeks. Some patients may require an additional 4 weeks of therapy. PRILOSEC, in combination with clarithromycin and amoxicillin, is indicated for treatment of patients with *H. pylori* infection and duodenal ulcer disease (active or up to 1-year history) to eradicate *H. pylori*. PRILOSEC, in combination with clarithromycin, is also indicated for treatment of patients with *H. pylori* infection and duodenal ulcer disease to eradicate *H. pylori*. Eradication of *H. pylori* has been shown to reduce the risk of duodenal ulcer recurrence. Among patients who fail therapy, PRILOSEC with clarithromycin is more likely to be associated with the development of clarithromycin resistance as compared with triple therapy. In patients who fail therapy, susceptibility testing should be done. If resistance to clarithromycin is demonstrated or susceptibility testing is not possible, alternative antimicrobial therapy should be instituted. (See the clarithromycin package insert, MICROBIOLOGY section.) **Gastric Ulcer:** PRILOSEC is indicated for short-term treatment (4-8 weeks) of active benign gastric ulcer. **Treatment of Gastroesophageal Reflux Disease (GERD):** *Symptomatic GERD*— PRILOSEC is indicated for the treatment of heartburn and other symptoms associated with GERD. *Erosive Esophagitis*— PRILOSEC is indicated for the short-term treatment (4-8 weeks) of erosive esophagitis which has been diagnosed by endoscopy. The efficacy of PRILOSEC used for longer than 8 weeks in these patients has not been established. In the rare instance of a patient not responding to 8 weeks of treatment, it may be helpful to give up to an additional 4 weeks of treatment. If there is recurrence of erosive esophagitis or GERD symptoms (e.g., heartburn), additional 4-8 week courses of omeprazole may be considered. **Maintenance of Healing of Erosive Esophagitis:** PRILOSEC is indicated to maintain healing of erosive esophagitis. Controlled studies do not extend beyond 12 months. **Pathological Hypersecretory Conditions:** PRILOSEC is indicated for the long-term treatment of pathological hypersecretory conditions (e.g., Zollinger-Ellison syndrome, multiple endocrine adenomas and systemic mastocytosis).

CONTRAINDICATIONS, Omeprazole: PRILOSEC Delayed-Release Capsules are contraindicated in patients with known hypersensitivity to any component of the formulation. **Clarithromycin:** Clarithromycin is contraindicated in patients with a known hypersensitivity to any macrolide antibiotic. Concomitant administration of clarithromycin with cisapride, pimozide, or terfenadine is contraindicated. There have been post-marketing reports of drug interactions when clarithromycin and/or erythromycin are co-administered with cisapride, pimozide, or terfenadine resulting in cardiac arrhythmias (QT prolongation, ventricular tachycardia, ventricular fibrillation, and torsades de pointes) most likely due to inhibition of hepatic metabolism of these drugs by erythromycin and clarithromycin. Fatalities have been reported. (Please refer to full prescribing information for clarithromycin before prescribing.) **Amoxicillin:** Amoxicillin is contraindicated in patients with a history of allergic reaction to any of the penicillins. (Please refer to full prescribing information for amoxicillin before prescribing.)

WARNINGS, Clarithromycin: CLARITHROMYCIN SHOULD NOT BE USED IN PREGNANT WOMEN EXCEPT IN CLINICAL CIRCUMSTANCES WHERE NO ALTERNATIVE THERAPY IS APPROPRIATE. IF PREGNANCY OCCURS WHILE TAKING CLARITHROMYCIN, THE PATIENT SHOULD BE APPRISED OF THE POTENTIAL HAZARD TO THE FETUS. (See WARNINGS in prescribing information for clarithromycin.) Amoxicillin: SERIOUS AND OCCASIONALLY FATAL HYPERSENSITIVITY (anaphylactic) REACTIONS HAVE BEEN REPORTED IN PATIENTS ON PENICILLIN THERAPY. THESE REACTIONS ARE MORE LIKELY TO OCCUR IN INDIVIDUALS WITH A HISTORY OF PENICILLIN HYPERSENSITIVITY AND/OR A HISTORY OF SENSITIVITY TO MULTIPLE ALLERGENS. BEFORE INITIATING THERAPY WITH AMOXICILLIN, CAREFUL INQUIRY SHOULD BE MADE CONCERNING PREVIOUS HYPERSENSITIVITY REACTIONS TO PENICILLINS, CEPHALOSPORINS OR OTHER ALLERGENS. IF AN ALLERGIC REACTION OCCURS, AMOXICILLIN SHOULD BE DISCONTINUED AND APPROPRIATE THERAPY INSTITUTED. **SERIOUS ANAPHYLACTIC REACTIONS REQUIRE IMMEDIATE EMERGENCY TREATMENT WITH EPINEPHRINE. OXYGEN, INTRAVENOUS STEROIDS AND AIRWAY MANAGEMENT, INCLUDING INTUBATION, SHOULD ALSO BE ADMINISTERED AS INDICATED.** (See WARNINGS in prescribing information for amoxicillin.) **Antimicrobials: Pseudomembranous colitis has been reported with nearly all antibacterial agents and may range in severity from mild to life-threatening. Therefore, it is important to consider this diagnosis in patients who present with diarrhea subsequent to the administration of antibacterial agents.** (See WARNINGS in prescribing information for clarithromycin and amoxicillin.)

PRECAUTIONS, General: Symptomatic response to therapy with omeprazole does not preclude the presence of gastric malignancy. Atrophic gastritis has been noted occasionally in gastric corpus biopsies from patients treated long-term with omeprazole. **Information for Patients:** PRILOSEC Delayed-Release Capsules should be taken before eating. Patients should be cautioned that the PRILOSEC Delayed-Release Capsule should not be opened, chewed or crushed, and should be swallowed whole. **Drug Interactions:** *Other*— Omeprazole can prolong the elimination of diazepam, warfarin and phenytoin, drugs that are metabolized by oxidation in the liver. Although in normal subjects no interaction with theophylline or propranolol was found, there have been clinical reports of interaction with other drugs metabolized via the cytochrome P-450 system (e.g., cyclosporine, disulfiram, benzodiazepines). Patients should be monitored to determine if it is necessary to adjust the dosage of these drugs when taken concomitantly with PRILOSEC. Because of its profound and long lasting inhibition of gastric acid secretion, it is theoretically possible that omeprazole may interfere with absorption of drugs where gastric pH is an important determinant of their bioavailability (e.g., ketoconazole, ampicillin esters, and iron salts). In the clinical trials, antacids were used concomitantly with the administration of PRILOSEC. *Combination Therapy with Clarithromycin*— Co-administration of omeprazole and clarithromycin have resulted in increases in plasma levels of omeprazole, clarithromycin, and 14-hydroxy-clarithromycin. (See CLINICAL PHARMACOLOGY, Pharmacokinetics: Combination Therapy with Antimi- crobials in full Prescribing Information.) Concomitant administration of clarithromycin with cisapride, pimozide, or terfenadine is contraindicated. There have been reports of an interaction between erythromycin and astemizole resulting in QT prolongation and torsades de pointes. Concomitant administration of erythromycin and astemizole is contraindicated. Because clarithromycin is also metabolized by cytochrome P-450, concomitant administration of clarithromycin with astemizole is not recommended. (See also CONTRAINDICATIONS, Clarithromycin, above. Please refer to full prescribing information for clarithromycin before prescribing.) **Carcinogenesis, Mutagenesis, Impairment of Fertility:** In two 24-month carcinogenicity studies in rats, omeprazole at daily doses of 1.7, 3.4, 13.8, 44.0 and 140.8 mg/kg/day (approximately 4 to 352 times the human dose, based on a patient weight of 50 kg and a human dose of 20 mg) produced gastric ECL cell carcinoids in a dose-related manner in both male and female rats; the incidence of this effect was markedly higher in female rats, which had higher blood levels of omeprazole. Gastric carcinoids seldom occur in the untreated rat. In addition, ECL cell hyperplasia was present in all treated groups of both sexes. In one of these studies, female rats were treated with 13.8 mg/kg/day omeprazole (approximately 35 times the human dose) for 1 year, then followed for an additional year without the drug. No carcinoids were seen in these rats. An increased incidence of treatment-related ECL cell hyperplasia was observed at the end of 1 year (94% treated vs 10% controls). By the second year the difference between treated and control rats was much smaller (46% vs 26%) but still showed more hyperplasia in the treated group. An unusual primary malignant tumor in the stomach was seen in one rat (2%). No similar tumor was seen in male or female rats treated for 2 years. For this strain of rat no similar tumor has been noted historically, but a finding involving only one tumor is difficult to interpret. A 78-week mouse carcinogenicity study of omeprazole did not show increased tumor occurrence, but the study was not conclusive. Omeprazole was not mutagenic in an *in vitro* Ames *Salmonella typhimurium* assay, an *in vitro* mouse lymphoma cell assay and an *in vivo* rat liver DNA damage assay. A mouse micronucleus test at 625 and 6250 times the human dose gave a borderline result, as did an *in vivo* bone marrow chromosome aberration test. A second mouse micronucleus study at 2000 times the human dose, but with different (suboptimal) sampling times, was negative. **Pregnancy: Omeprazole:** *Pregnancy Category C*— In rabbits, omeprazole in a dose range of 6.9 to 69.1 mg/kg/day (approximately 17 to 172 times the human dose) produced dose-related increases in embryo-lethality, fetal resorptions and pregnancy disruptions. In rats, dose-related embryo/fetal toxicity and postnatal developmental toxicity were observed in offspring resulting from parents treated with omeprazole 13.8 to 138.0 mg/kg/day (approximately 35 to 345 times the human dose). There are no adequate or well-controlled studies in pregnant women. Sporadic reports have been received of congenital abnormalities occurring in infants born to women who have received omeprazole during pregnancy. Omeprazole should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus. **Clarithromycin:** *Pregnancy Category C*— See WARNINGS (above) and full prescribing information for clarithromycin before using in pregnant women. **Nursing Mothers:** It is not known whether omeprazole is excreted in human milk. In rats, omeprazole administration during late gestation and lactation at doses of 13.8 to 138 mg/kg/day (35 to 345 times the human dose) resulted in decreased weight gain in pups. Because many drugs are excreted in human milk, because of the potential for serious adverse reactions in nursing infants from omeprazole, and because of the potential for tumorigenicity shown for omeprazole in rat carcinogenicity studies, a decision should be made whether to discontinue nursing or discontinue the drug, taking into account the importance of the drug to the mother. **Pediatric Use:** Safety and effectiveness in pediatric patients have not been established.

ADVERSE REACTIONS: In the U.S. clinical trial population of 465 patients (including duodenal ulcer, Zollinger-Ellison syndrome and resistant ulcer patients), the following adverse experiences were reported to occur in 1% or more of patients on therapy with PRILOSEC® (omeprazole). Numbers in parentheses indicate percentages of the adverse experiences considered by investigators as possibly, probably, or definitely related to the drug.

	Omeprazole (n=465)	Placebo (n=64)	Ranitidine (n=195)
Headache	6.9 (2.4)	6.3	7.7 (2.6)
Diarrhea	3.0 (1.9)	3.1 (1.6)	2.1 (0.5)
Abdominal Pain	2.4 (0.4)	3.1	2.1
Nausea	2.2 (0.9)	3.1	4.1 (0.5)
URI	1.9	1.6	2.6
Dizziness	1.5 (0.6)	0.0	2.6 (1.0)
Vomiting	1.5 (0.4)	4.7	1.5 (0.5)
Rash	1.5 (1.1)	0.0	0.0
Constipation	1.1 (0.9)	0.0	0.0
Cough	1.1	0.0	1.5
Asthenia	1.1 (0.2)	1.6 (1.6)	1.5 (1.0)
Back Pain	1.1	0.0	0.5

The following adverse reactions which occurred in 1% or more of omeprazole-treated patients have been reported in international double-blind, and open-label, clinical trials in which 2,631 patients and subjects received omeprazole.

Incidence of Adverse Experiences ≥ 1% Causal Relationship not Assessed

		Omeprazole (n=2,631)	Placebo (n=120)
Body as a Whole, site unspecified	Abdominal pain	5.2	3.3
	Asthenia	1.3	0.8
Digestive System	Constipation	1.5	0.8
	Diarrhea	3.7	2.5
	Flatulence	2.7	5.8
	Nausea	4.0	6.7
	Vomiting	3.2	10.0
	Acid regurgitation	1.9	3.3
Nervous System/Psychiatric	Headache	2.9	2.5

Additional adverse experiences occurring in <1% of patients or subjects in domestic and/or international trials, or occurring since the drug was marketed, are shown below within each body system. In many instances, the relationship to PRILOSEC was unclear. *Body As a Whole:* Allergic reactions including, rarely, anaphylaxis (see also *Skin* below), fever, pain, fatigue, malaise, abdominal swelling. *Cardiovascular:* Chest pain or angina, tachycardia, bradycardia, palpitation, elevated blood pressure, peripheral edema. *Gastrointestinal:* Pancreatitis (some fatal), anorexia, irritable colon, flatulence, fecal discoloration, esophageal candidiasis, mucosal atrophy of the tongue, dry mouth. During treatment with omeprazole, gastric fundic gland polyps have been noted rarely. These polyps are benign and appear to be reversible when treatment is discontinued. Gastro-duodenal carcinoids have been reported in patients with ZE syndrome on long-term treatment with PRILOSEC. This finding is believed to be a manifestation of the underlying condition, which is known to be associated with such tumors. *Hepatic:* Mild and, rarely, marked elevations of liver function tests [ALT (SGPT), AST (SGOT), γ-glutamyl transpeptidase, alkaline phosphatase, and bilirubin (jaundice)]. In rare instances, overt liver disease has occurred, including hepatocellular, cholestatic, or mixed hepatitis, liver necrosis (some fatal), hepatic failure (some fatal), and hepatic encephalopathy. *Metabolic/Nutritional:* Hyponatremia, hypoglycemia, weight gain. *Musculoskeletal:* Muscle cramps, myalgia, muscle weakness, joint pain, leg pain. *Nervous System/Psychiatric:* Psychic disturbances including depression, aggression, hallucinations, confusion, insomnia, nervousness, tremors, apathy, somnolence, anxiety, dream abnormalities; vertigo; paresthesia; hemifacial dysesthesia. *Respiratory:* Epistaxis, pharyngeal pain. *Skin:* Rash and, rarely, cases of severe generalized skin reactions including toxic epidermal necrolysis (TEN; some fatal), Stevens-Johnson syndrome, and erythema multiforme (some severe); purpura and/or petechiae (some with rechallenge); skin inflammation, urticaria, angioedema, pruritus, alopecia, dry skin, hyperhidrosis. *Special Senses:* Tinnitus, taste perversion. *Urogenital:* Interstitial nephritis (some with positive rechallenge), urinary tract infection, microscopic pyuria, urinary frequency, elevated serum creatinine, proteinuria, hematuria, glycosuria, testicular pain, gynecomastia. *Hematologic:* Rare instances of pancytopenia, agranulocytosis (some fatal), thrombocytopenia, neutropenia, anemia, leucocytosis, and hemolytic anemia have been reported. **Combination Therapy for *H. pylori* Eradication:** dual therapy with PRILOSEC and clarithromycin or triple therapy with PRILOSEC, clarithromycin, and amoxicillin. Adverse experiences that have occurred have been limited to those that have been previously reported with omeprazole, clarithromycin, or amoxicillin. *Triple Therapy (PRILOSEC/clarithromycin/amoxicillin)*— The most frequent adverse experiences observed in clinical trials using combination therapy with PRILOSEC, clarithromycin, and amoxicillin (n = 274) were diarrhea (14%), taste perversion (10%), and headache (7%). None of these occurred at a higher frequency than that reported by patients taking the antimicrobial drugs alone. *Dual Therapy (PRILOSEC/clarithromycin)*— Adverse experiences observed in controlled clinical trials using combination therapy with PRILOSEC and clarithromycin (n = 346) which differed from those previously described for omeprazole alone were: Taste perversion (15%), tongue discoloration (2%), rhinitis (2%), pharyngitis (1%) and flu syndrome (1%). For more information on clarithromycin or amoxicillin, refer to the respective package inserts, ADVERSE REACTIONS sections.

OVERDOSAGE: Rare reports have been received of overdosage with omeprazole. Doses ranged from 320 mg to 900 mg (16-45 times the usual recommended clinical dose). Manifestations were variable, but included confusion, drowsiness, blurred vision, tachycardia, nausea, diaphoresis, flushing, headache, and dry mouth. Symptoms were transient, and no serious clinical outcome has been reported. No specific antidote for omeprazole overdosage is known. Omeprazole is extensively protein bound and is, therefore, not readily dialyzable. In the event of overdosage, treatment should be symptomatic and supportive.

DOSAGE AND ADMINISTRATION, Short-Term Treatment of Active Duodenal Ulcer: The recommended adult oral dose of PRILOSEC is 20 mg once daily. Most patients heal within 4 weeks. Some patients may require an additional 4 weeks of therapy. (See INDICATIONS AND USAGE.) ***H. pylori* Eradication for the Reduction of the Risk of Duodenal Ulcer Recurrence:** *Triple Therapy (PRILOSEC/clarithromycin/amoxicillin)*— The recommended adult oral regimen is PRILOSEC 20 mg plus clarithromycin 500 mg plus amoxicillin 1000 mg each given twice daily for 10 days. In patients with an ulcer present at the time of initiation of therapy, an additional 18 days of PRILOSEC 20 mg once daily is recommended for ulcer healing and symptom relief. *Dual Therapy (PRILOSEC/clarithromycin)*— The recommended adult oral regimen is PRILOSEC 40 mg once daily plus clarithromycin 500 mg t.i.d. for 14 days. In patients with an ulcer present at the time of initiation of therapy, an additional 14 days of PRILOSEC 20 mg once daily is recommended for ulcer healing and symptom relief. Please refer to clarithromycin full prescribing information for CONTRAINDICATIONS and WARNING, and for information regarding dosing in elderly and renally impaired patients (PRECAUTIONS: General, PRECAUTIONS: Geriatric Use and PRECAUTIONS: Drug Interactions). Please refer to amoxicillin full prescribing information for CONTRAINDICATIONS and WARNINGS. **Gastric Ulcer:** The recommended adult oral dose is 40 mg once a day for 4 to 8 weeks. (See INDICATIONS AND USAGE, Gastric Ulcer.) **Gastroesophageal Reflux Disease (GERD):** The recommended adult oral dose for the treatment of patients with symptomatic GERD and no esophageal lesions is 20 mg daily for up to 4 weeks. The recommended adult oral dose for the treatment of patients with erosive esophagitis and accompanying symptoms due to GERD is 20 mg daily for 4 to 8 weeks. (See INDICATIONS AND USAGE.) **Maintenance of Healing of Erosive Esophagitis:** The recommended adult oral dose is 20 mg daily. **Pathological Hypersecretory Conditions:** The dosage of PRILOSEC in patients with pathological hypersecretory conditions varies with the individual patient. The recommended adult oral starting dose is 60 mg once a day. Doses should be adjusted to individual patient needs and should continue for as long as clinically indicated. Doses up to 120 mg t.i.d. have been administered. Daily dosages of greater than 80 mg should be administered in divided doses. No dosage adjustment is necessary for patients with renal impairment, hepatic dysfunction or for the elderly.

Manufactured by: Merck & Co., Inc. West Point, PA 19486, USA

Issued December 1998

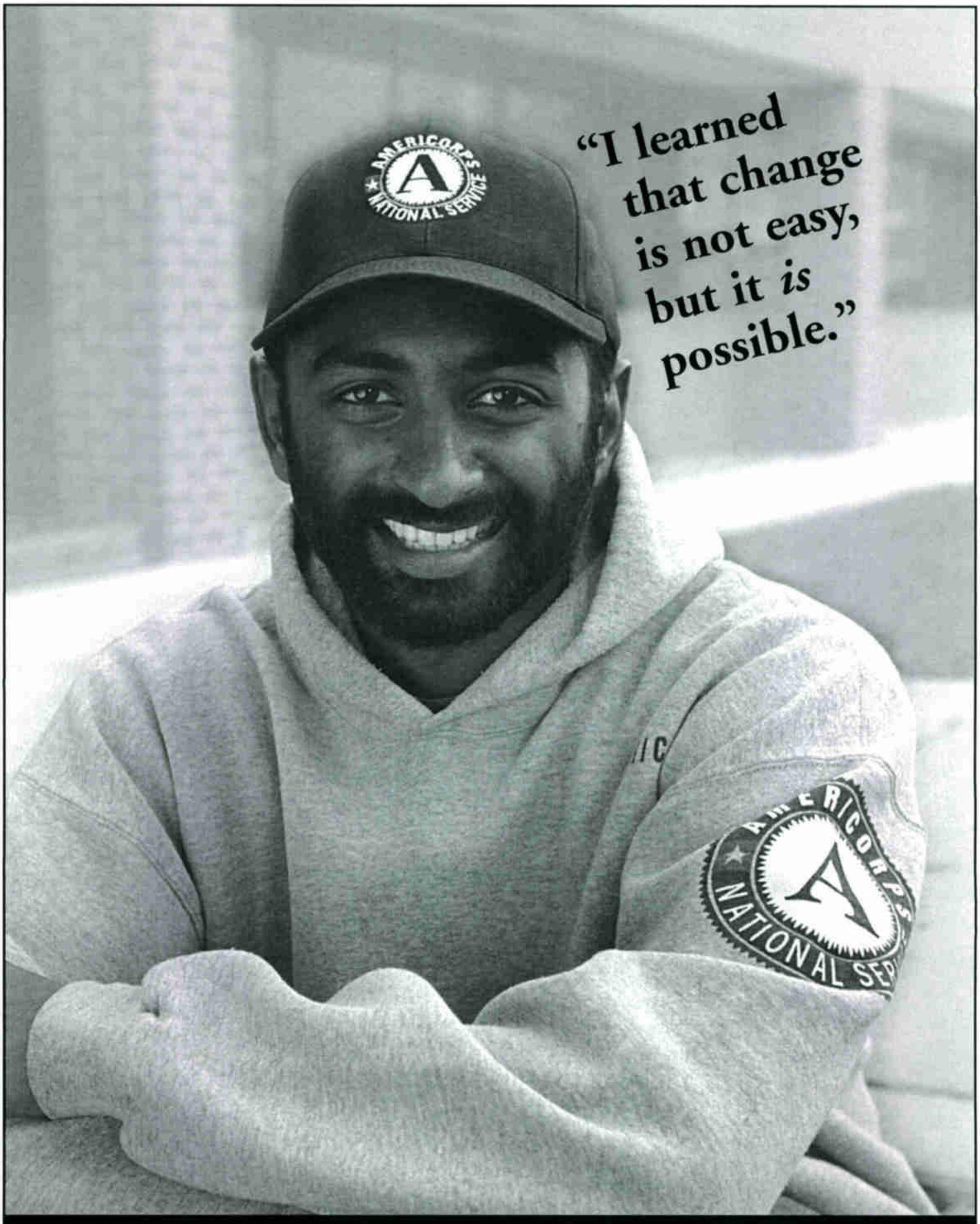
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NOTE: This summary provides important information about PRILOSEC. If you would like more information, ask your doctor or pharmacist to let you read the professional labeling and then discuss it with them.

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When Sanjay Garla left college, he doubted whether his classroom lessons related to the real world. But joining AmeriCorps*VISTA helped him make the connection he had been lacking. By the end of the year, he had launched a public education drive to help community residents get the health care they needed.
"AmeriCorps*VISTA challenged me and helped me grow," Sanjay says. "After that year, I returned to school with new skills and a better sense of direction."

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POINT OF VIEW

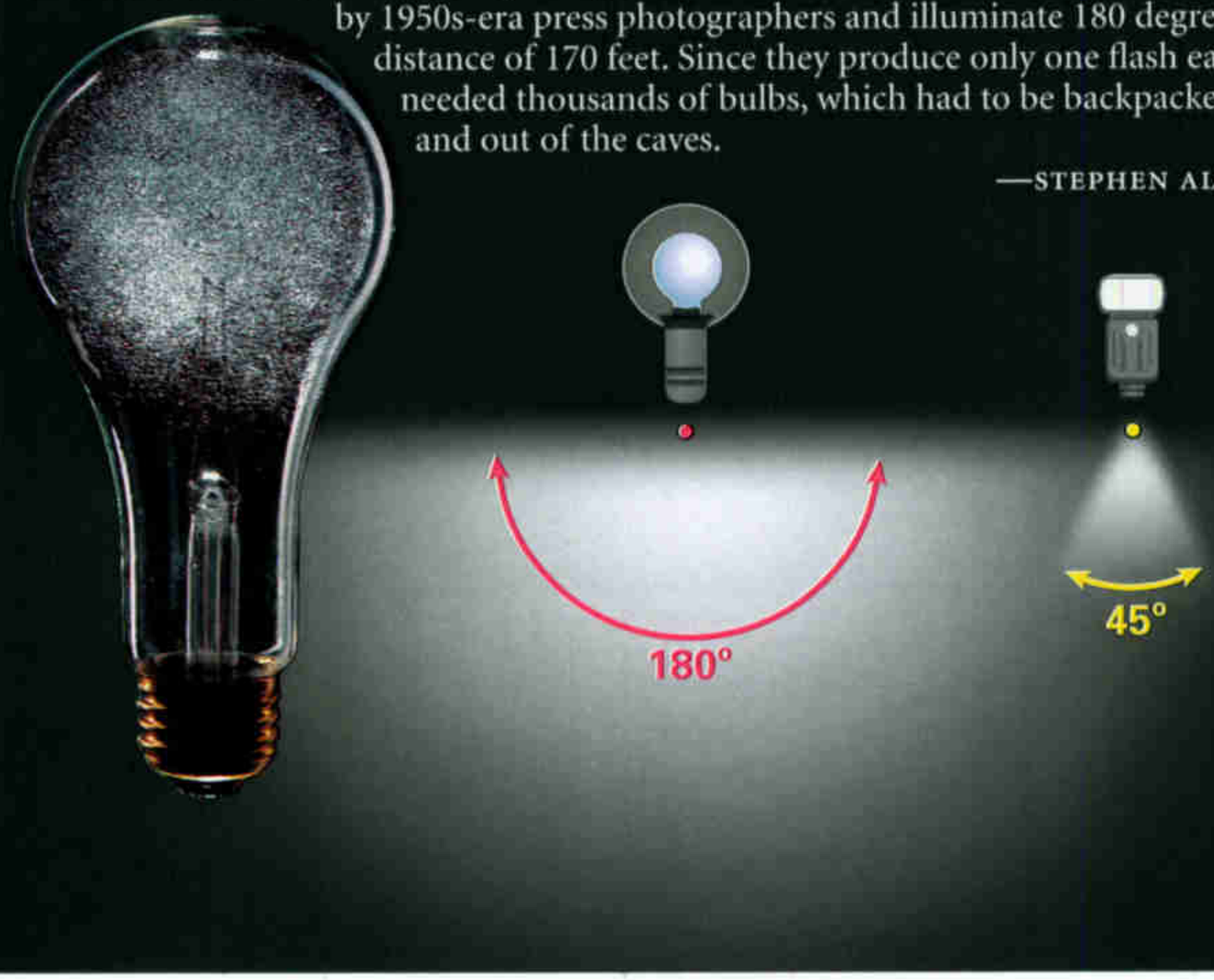


STEPHEN ALVAREZ WITH ELIZABETH MOTLOW; ART BY JENNIFER C. CHRISTIANSEN, NGS STAFF

Shedding Light on the Subject

The Chiquibul cave assignment presented a tremendous technical challenge. The caverns lie in a remote jungle, are difficult to negotiate, and contain absolutely no light. Modern strobe lights bright enough to illuminate a section of the vast Sand Passage (pages 58-60) weigh 50 pounds apiece and require an electric generator. Camera-mounted flashes small enough for my assistants and me to carry produce only a short and narrow cone of light (diagram, at right). I relied, therefore, on old-fashioned flashbulbs (below). The large lightweight bulbs—made before I was born—were used by 1950s-era press photographers and illuminate 180 degrees to a distance of 170 feet. Since they produce only one flash each, we needed thousands of bulbs, which had to be backpacked into and out of the caves.

—STEPHEN ALVAREZ



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THE NEXT GENERATION

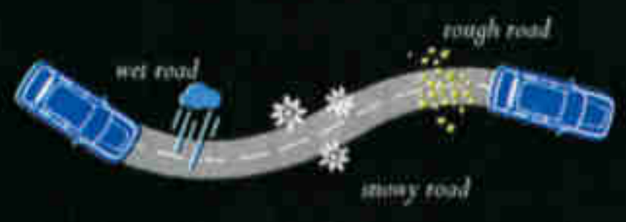
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Behind the Scenes



◄ BEFORE

AFTER ►



GARY BELL (ABOVE AND BELOW); MARK THIESSEN, NGS

Sealing Our Cameras' Fate

If you want a good picture of a great white shark, disguise your camera as its favorite meal. That was the idea behind the "sealcams" used by our magazine and television crews in False Bay, South Africa, for this issue's coverage. Photoengineer Walter Boggs (above) designed and built the sealcams, which were first tested in the Potomac River's shark-free waters. By the time NG Television producer John Bredar (above right, at right) and photographer David Doubilet, at left, had finished work on location, the equipment had taken a real beating. "The sealcams gave us that crucial one-second head start to begin filming before the sharks' heads breached the surface," says John. But at one point John thought their time might be up. In an area where local lore has sharks leaping into passing boats, a frantic, already wounded seal jumped up onto the stern of the Society's craft before jumping back into the water. "I was sure a ton of great white was going to follow him," John says.



His Toothsome Opportunity

He may have written the most famous shark book ever, but author Peter Benchley had never before gotten so close to a real-life set of great white jaws. Observing the dissection of this 18-footer was "like watching someone take apart a Rolls-Royce," though the shark's accidental death after becoming entangled in fishing line was, he says, a tragedy. This shark, a female, was around 20 years old and, given the state of her ovaries, had clearly borne some young within the past year. "These animals breed so seldom," says Peter, "that *the death of even* one is a geometric loss."



THERE'S A CHANCE OF FLOODING IN YOUR AREA. ARE YOU WILLING TO BET THE HOUSE ON IT?

Well, are you? You'd be surprised at how many homeowners are still willing to risk everything they have over a small insurance premium.

The sad fact is that floods are a nightmare not just experienced by "other people." In too many cases, we don't have flood insurance because we make the mistake of believing our homeowners' insurance covers flood damage. It doesn't.

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The National Flood Insurance Program is part of the Federal Emergency Management Agency.

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NATIONAL FLOOD INSURANCE PROGRAM

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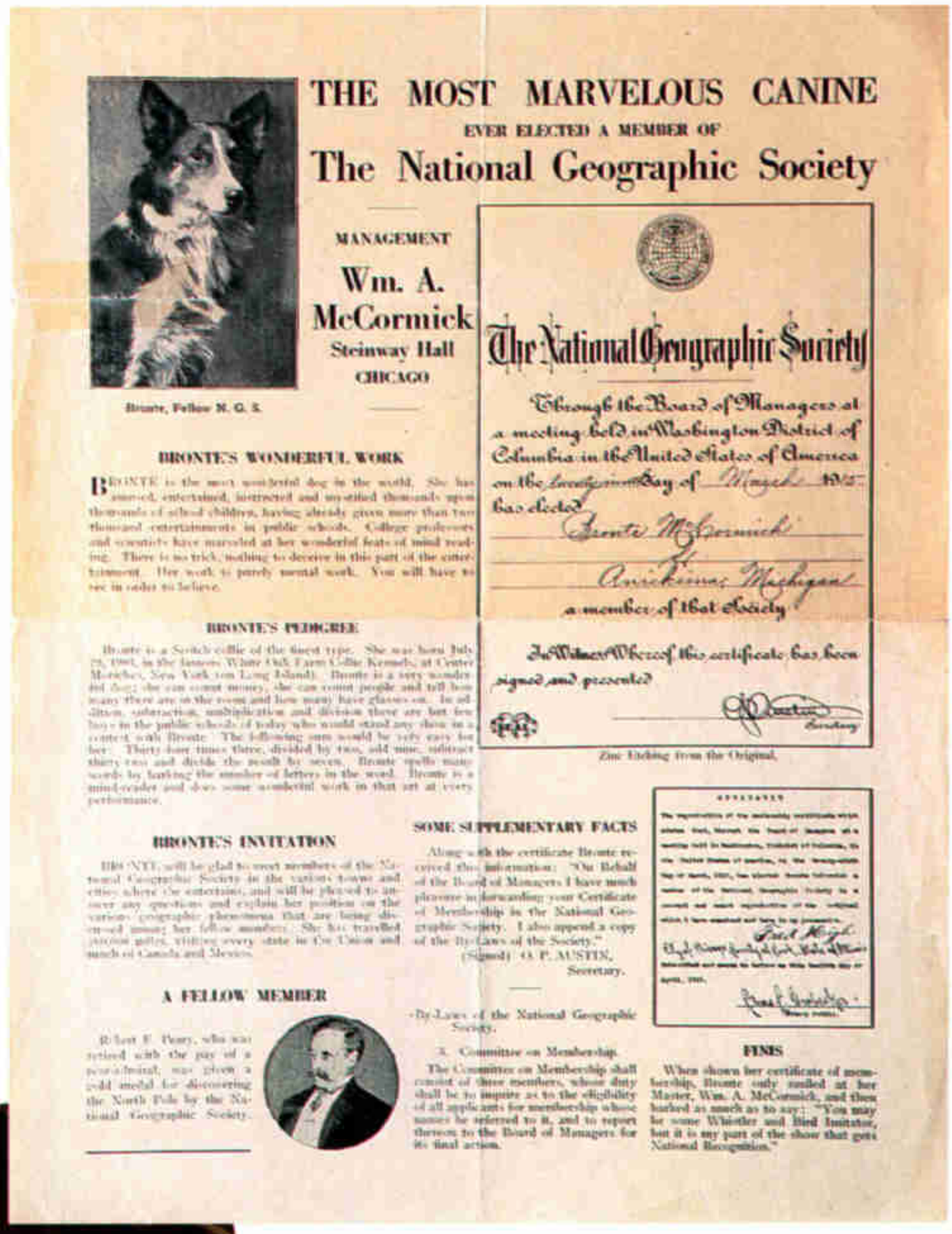
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REPUBLIC PICTURES, 1947

Memberships to Remember

"I've been nominated for membership in the National Geographic Society," crowed a young George Bailey (above) in the 1946 film *It's a Wonderful Life.* It was something to wag about, too, for Bronte, a vaudevillian dog whose owner must have thought this 1915 membership (right) would add to his performing pet's reputation.



THE MOST MARVELOUS CANINE
EVER ELECTED A MEMBER OF
The National Geographic Society

MANAGEMENT
Wm. A. McCormick
Steinway Hall
CHICAGO

Bronte, Fellow N. G. S.

BRONTE'S WONDERFUL WORK

BRONTE is the most wonderful dog in the world. She has amused, entertained, instructed and mystified thousands upon thousands of school children, having already given more than two thousand entertainments in public schools. College professors and scientists have marveled at her wonderful feats of mind reading. There is no trick, nothing to deceive in this part of the entertainment. Her work is purely mental work. You will have to see in order to believe.

BRONTE'S PEDIGREE

Bronte is a Scotch collie of the finest type. She was born July 29, 1907, in the famous White Oak Farm Collie Kennels, at Center Moriches, New York (on Long Island). Bronte is a very wonderful dog; she can count money, she can count people and tell how many there are in the room and how many have glasses on. In addition, subtraction, multiplication and division there are but few boys in the public schools of today who would stand any show in a contest with Bronte. The following sum would be very easy for her: Thirty-four times three, divided by two, add nine, subtract thirty-two and divide the result by seven. Bronte spells many words by tasting the number of letters in the word. Bronte is a mind-reader and does some wonderful work in that art at every performance.

BRONTE'S INVITATION

BRONTE will be glad to meet members of the National Geographic Society in the various towns and cities where she entertains, and will be pleased to answer any questions and explain her position on the various geographic phenomena that are being discussed among her fellow members. She has travelled across seven times, visiting every state in the Union and much of Canada and Mexico.

A FELLOW MEMBER

Robert E. Peary, who was retired with the pay of a rear-admiral, was given a gold medal for discovering the North Pole by the National Geographic Society.

SOME SUPPLEMENTARY FACTS

Along with the certificate Bronte received this information: "On Behalf of the Board of Managers I have much pleasure in forwarding your Certificate of Membership in the National Geographic Society. I also append a copy of the By-Laws of the Society."

(Signed) O. P. AUSTIN,
Secretary.

By-Laws of the National Geographic Society.

3. Committee on Membership.

The Committee on Membership shall consist of three members, whose duty shall be to inquire as to the eligibility of all applicants for membership whose names be referred to it, and to report thereon to the Board of Managers for its final action.

The National Geographic Society

Through the Board of Managers at a meeting held in Washington District of Columbia in the United States of America on the twenty-seventh Day of March 1915 has elected

Bronte McCormick

Ann Arbor, Michigan

a member of that Society

In Witness Whereof this certificate has been signed and presented

Secretary.

Zinc Etching from the Original.

FINIS

When shown her certificate of membership, Bronte only smiled at her Master, Wm. A. McCormick, and then barked as much as to say: "You may be some Whistler and Bird Imitator, but it is my part of the show that gets National Recognition."



Artist James Gurney, creator of the *Dinotopia* book series, counts himself among our lifetime members. For Gurney—as for many—a prime tenet of membership is holding on to those old magazines. His painting (left) of a man and his grandson "was the product of a lot of dusty research in attics around town. Friends let me borrow their old treasures to use as props—the uniform, the clock, the photos—but I got to use my own GEOGRAPHICS."

Now that the GEOGRAPHIC is available on newsstands, what does membership mean? The magazine began as the official journal of a scholarly society—and it still is, 111 years later. Members' dues actively support hundreds of research projects all over the world.



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FOR THE CENTRAL DISTRICT
OF CALIFORNIA

TO ALL PERSONS WHO RECEIVED GAMMAGARD® IVIG (AN INTRAVENOUS IMMUNE GLOBULIN) BETWEEN JANUARY 1, 1993 AND FEBRUARY 24, 1994 AND THEIR ESTATES, REPRESENTATIVES, AND SURVIVING SPOUSES, PARENTS, AND CHILDREN

Your rights may be affected by a proposed class action settlement of claims alleging exposure to and/or infection with Hepatitis C Virus ("HCV") from the use of Gammagard® IVIG between January 1, 1993 and February 24, 1994. Your rights may be affected even if you have never been infected with HCV. You may be entitled to free HCV Testing and settlement payments.

You should contact healthcare providers and consult medical records to determine if you or your deceased spouse, parent, or child received an infusion of Gammagard® IVIG between January 1, 1993 and February 24, 1994. The medical conditions for which Gammagard® IVIG was lawfully prescribed include, but are not limited to, the following:

Primary Immune Deficiencies such as:

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VISIT: http://www.hcv-claims.com

PLEASE DO NOT CONTACT THE COURT

PLEASE NOTE THESE IMPORTANT DEADLINES:

April 24, 2000, Deadline to Request a Free HCV Test Kit to Take to a Doctor to Get Tested for HCV

June 30, 2000, Deadline to Exclude Yourself from or "Opt Out" of the Proposed Settlement

June 30, 2000, Deadline to File a Claim with the Proposed Settlement

June 30, 2000, Deadline to Comment on the Proposed Settlement



DAVID HISER

Still Holding On

A life's work washed away last October, when the worst floods in 400 years ravaged Veracruz, Mexico. Society grantee Jeffrey Wilkerson (above) had spent 36 years there studying ancient cultures and extreme weather in the tropics. He gained firsthand knowledge as the floods roared through the region, ripping entire buildings off their foundations. He is lucky to be alive. Jeff and five staff members spent two days clinging to trees until the surging waters abated.

"Six of our seven buildings simply don't exist anymore," he says. Thousands of tons of silt cover the site. He's determined to save what he can and rebuild what he can't: "I don't give up." To help, you can contact the Institute for Cultural Ecology of the Tropics at its U.S. office in Harlingen, Texas (956-412-9250).



SUSAN WELCHMAN, NGS

On the Road to Ruin

"We eventually got it upright," says Lynn Johnson of the bush taxi that sank in mud while she was shooting in Madagascar for "Nature's Rx." Most photographers take such setbacks in stride, and Lynn was no exception. "I don't worry," she says. "I just pack a lot of antacids."

TEXT BY MAGGIE ZACKOWITZ

■ FOR INFORMATION

Call: 1-800-NGS-LINE Toll free from U.S., Canada, 8 a.m.–midnight ET, Mon.–Fri., 8:30 a.m.–7 p.m. ET, Sat.
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If You're Trying To Lower Your Cholesterol, But Your Numbers Still Come Up High...



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LIPITOR also significantly lowers total cholesterol and triglycerides while raising HDL "good" cholesterol. And LIPITOR is taken only once a day, at any time of day, with or without food.

ONLY YOUR DOCTOR

or healthcare provider knows if LIPITOR is right for you. Some people should not take LIPITOR, including those with liver disease or possible liver problems, women who are nursing, pregnant, or who may become pregnant, or people who are allergic to any of the ingredients in LIPITOR. It's important to tell your doctor about any medications you are currently taking to avoid possible serious drug interactions. Your doctor may perform simple blood tests to monitor liver function before and during treatment.

LIPITOR IS GENERALLY WELL TOLERATED.

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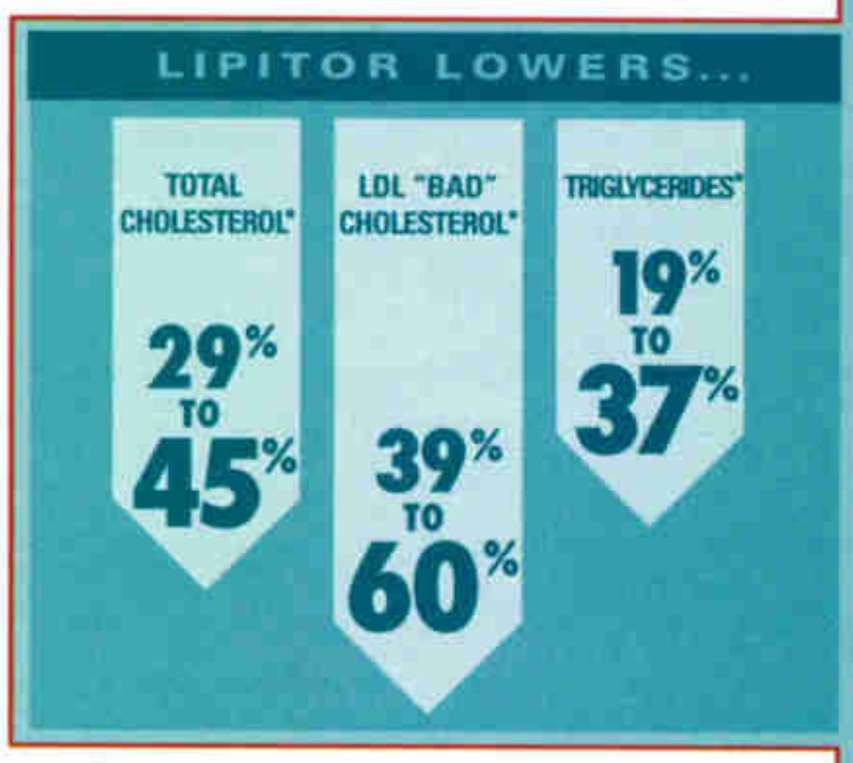


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LIPITOR® (Atorvastatin Calcium) Tablets
Brief Summary of Prescribing Information

CONTRAINDICATIONS: Active liver disease or unexplained persistent elevations of serum transaminases. Hypersensitivity to any component of this medication. **Pregnancy and Lactation:** Atherosclerosis is a chronic process and discontinuation of lipid-lowering drugs during pregnancy should have little impact on the outcome of long-term therapy of primary hypercholesterolemia. Cholesterol and other products of cholesterol biosynthesis are essential components for fetal development (including synthesis of steroids and cell membranes). Since HMG-CoA reductase inhibitors decrease cholesterol synthesis and possibly the synthesis of other biologically active substances derived from cholesterol, they may cause fetal harm when administered to pregnant women. Therefore, HMG-CoA reductase inhibitors are contraindicated during pregnancy and in nursing mothers. ATORVASTATIN SHOULD BE ADMINISTERED TO WOMEN OF CHILDBEARING AGE ONLY WHEN SUCH PATIENTS ARE HIGHLY UNLIKELY TO CONCEIVE AND HAVE BEEN INFORMED OF THE POTENTIAL HAZARDS. If the patient becomes pregnant while taking this drug, therapy should be discontinued and the patient apprised of the potential hazard to the fetus.

WARNINGS: Liver Dysfunction — HMG-CoA reductase inhibitors, like some other lipid-lowering therapies, have been associated with biochemical abnormalities of liver function. **Persistent elevations (>3 times the upper limit of normal [ULN] occurring on 2 or more occasions) in serum transaminases occurred in 0.7% of patients who received atorvastatin in clinical trials. The incidence of these abnormalities was 0.2%, 0.2%, 0.6%, and 2.3% for 10, 20, 40, and 80 mg, respectively.** One patient in clinical trials developed jaundice. Increases in liver function tests (LFT) in other patients were not associated with jaundice or other clinical signs or symptoms. Upon dose reduction, drug interruption, or discontinuation, transaminase levels returned to or near pretreatment levels without sequelae. Eighteen of 30 patients with persistent LFT elevations continued treatment with a reduced dose of atorvastatin. **It is recommended that liver function tests be performed prior to and at 12 weeks following both the initiation of therapy and any elevation of dose, and periodically (eg, semiannually) thereafter.** Liver enzyme changes generally occur in the first 3 months of treatment with atorvastatin. Patients who develop increased transaminase levels should be monitored until the abnormalities resolve. Should an increase in ALT or AST of >3 times ULN persist, reduction of dose or withdrawal of atorvastatin is recommended. Atorvastatin should be used with caution in patients who consume substantial quantities of alcohol and/or have a history of liver disease. Active liver disease or unexplained persistent transaminase elevations are contraindications to the use of atorvastatin (see CONTRAINDICATIONS). **Skeletal Muscle — Rhabdomyolysis with acute renal failure secondary to myoglobinuria has been reported with other drugs in this class.** Uncomplicated myalgia has been reported in atorvastatin-treated patients (see ADVERSE REACTIONS). Myopathy, defined as muscle aches or muscle weakness in conjunction with increases in creatine phosphokinase (CPK) values >10 times ULN, should be considered in any patient with diffuse myalgias, muscle tenderness or weakness, and/or marked elevation of CPK. Patients should be advised to report promptly unexplained muscle pain, tenderness or weakness, particularly if accompanied by malaise or fever. Atorvastatin therapy should be discontinued if markedly elevated CPK levels occur or myopathy is diagnosed or suspected. The risk of myopathy during treatment with other drugs in this class is increased with concurrent administration of cyclosporine, fibric acid derivatives, erythromycin, niacin, or azole antifungals. Physicians considering combined therapy with atorvastatin and fibric acid derivatives, erythromycin, immunosuppressive drugs, azole antifungals, or lipid-lowering doses of niacin should carefully weigh the potential benefits and risks and should carefully monitor patients for any signs or symptoms of muscle pain, tenderness, or weakness, particularly during the initial months of therapy and during any periods of upward dosage titration of either drug. Periodic creatine phosphokinase (CPK) determinations may be considered in such situations, but there is no assurance that such monitoring will prevent the occurrence of severe myopathy. **Atorvastatin therapy should be temporarily withheld or discontinued in any patient with an acute, serious condition suggestive of a myopathy or having a risk factor predisposing to the development of renal failure secondary to rhabdomyolysis (eg, severe acute infection, hypotension, major surgery, trauma, severe metabolic, endocrine and electrolyte disorders, and uncontrolled seizures).**

PRECAUTIONS: General — Before instituting therapy with atorvastatin, an attempt should be made to control hypercholesterolemia with appropriate diet, exercise, and weight reduction in obese patients, and to treat other underlying medical problems (see INDICATIONS AND USAGE in full prescribing information). **Information for Patients** — Patients should be advised to report promptly unexplained muscle pain, tenderness, or weakness, particularly if accompanied by malaise or fever. **Drug Interactions** — The risk of myopathy during treatment with other drugs of this class is increased with concurrent administration of cyclosporine, fibric acid derivatives, niacin (nicotinic acid), erythromycin, azole antifungals (see WARNINGS, Skeletal Muscle). ***Antacid:*** When atorvastatin and Maalox® TC suspension were coadministered, plasma concentrations of atorvastatin decreased approximately 35%. However, LDL-C reduction was not altered. ***Antipyrine:*** Because atorvastatin does not affect the pharmacokinetics of antipyrine, interactions with other drugs metabolized via the same cytochrome isozymes are not expected. ***Colestipol:*** Plasma concentrations of atorvastatin decreased approximately 25% when colestipol and atorvastatin were coadministered. However, LDL-C reduction was greater when atorvastatin and colestipol were coadministered than when either drug was given alone. ***Cimetidine:*** Atorvastatin plasma concentrations and LDL-C reduction were not altered by coadministration of cimetidine. ***Digoxin:*** When multiple doses of atorvastatin and digoxin were coadministered, steady-state plasma digoxin concentrations increased by approximately 20%. Patients taking digoxin should be monitored appropriately. ***Erythromycin:*** In healthy individuals, plasma concentrations of atorvastatin increased approximately 40% with coadministration of atorvastatin and erythromycin, a known inhibitor of cytochrome P450 3A4 (see WARNINGS, Skeletal Muscle). ***Oral Contraceptives:*** Coadministration of atorvastatin and an oral contraceptive increased AUC values for norethindrone and ethinyl estradiol by approximately 30% and 20%. These increases should be considered when selecting an oral contraceptive for a woman taking atorvastatin. ***Warfarin:*** Atorvastatin had no clinically significant effect on prothrombin time when administered to patients receiving chronic warfarin treatment. **Endocrine Function** — HMG-CoA reductase inhibitors interfere with cholesterol synthesis and theoretically might blunt adrenal and/or gonadal steroid production. Clinical studies have shown that atorvastatin does not reduce basal plasma cortisol concentration or impair adrenal reserve. The effects of HMG-CoA reductase inhibitors on male fertility have not been studied in adequate numbers of patients. The effects, if any, on the pituitary-gonadal axis in premenopausal women are unknown. Caution should be exercised if an HMG-CoA reductase inhibitor is administered concomitantly with drugs that may decrease the levels or activity of endogenous steroid hormones, such as ketoconazole, spironolactone, and cimetidine. **CNS Toxicity** — Brain hemorrhage was seen in a female dog treated for 3 months at 120 mg/kg/day. Brain hemorrhage and optic nerve vacuolation were seen in another female dog that was sacrificed in moribund condition after 11 weeks of escalating doses up to 280 mg/kg/day. The 120 mg/kg dose resulted in a systemic exposure approximately 16 times the human plasma area-under-the-curve (AUC, 0-24 hours) based on the maximum human dose of 80 mg/day. A single tonic convulsion was seen in each of 2 male dogs (one treated at 10 mg/kg/day and one at 120 mg/kg/day) in a 2-year study. No CNS lesions have been observed in mice after chronic treatment for up to 2 years at doses up to 400 mg/kg/day or in rats at doses up to 100 mg/kg/day. These doses were 6 to 11 times (mouse) and 8 to 16 times (rat) the human AUC (0-24) based on the maximum recommended human dose of 80 mg/day. CNS vascular lesions, characterized by perivascular hemorrhages, edema, and mononuclear cell infiltration of perivascular spaces, have been observed in dogs treated with other members of this class. A chemically similar drug in this class produced optic nerve degeneration (Wallerian degeneration of retinogeniculate fibers) in clinically normal dogs in a dose-dependent fashion at a dose that produced plasma drug levels about 30 times higher than the mean drug level in humans taking the highest recommended dose. **Carcinogenesis, Mutagenesis, Impairment of Fertility** — In a 2-year carcinogenicity study in rats at dose levels of 10, 30, and 100 mg/kg/day, 2 rare tumors were found in muscle in high-dose females: in one, there was a rhabdomyosarcoma and, in another, there was a fibrosarcoma. This dose represents a plasma AUC (0-24) value of approximately 16 times the mean human plasma drug exposure after an 80 mg oral dose. A 2-year carcinogenicity study in mice given 100, 200, or 400 mg/kg/day resulted in a significant increase in liver adenomas in high-dose males and liver carcinomas in high-dose females. These findings occurred at plasma AUC (0-24) values of approximately 6 times the mean human plasma drug exposure after an 80 mg oral dose. *In vitro*, atorvastatin was not mutagenic or clastogenic in the following tests with and without metabolic activation: the Ames test with *Salmonella typhimurium* and *Escherichia coli*, the HGPRT forward mutation assay in Chinese hamster lung cells, and the chromosomal aberration assay in Chinese hamster lung cells. Atorvastatin was negative in the *in vivo* mouse micronucleus test. Studies in rats performed at doses up to 175 mg/kg (15 times the human exposure) produced no changes in fertility. There was aplasia and aspermia in the epididymis of 2 of 10 rats treated with 100 mg/kg/day of atorvastatin for 3 months (16 times the human AUC at the 80 mg dose); testis weights were significantly lower at 30 and 100 mg/kg and epididymal weight was lower at 100 mg/kg. Male rats given 100 mg/kg/day for 11 weeks prior to mating had decreased sperm motility, spermatid head concentration, and increased abnormal sperm. Atorvastatin caused no adverse effects on semen parameters, or reproductive organ histopathology in dogs given doses of 10, 40, or 120 mg/kg for two years. **Pregnancy: Pregnancy Category X — See CONTRAINDICATIONS.** Safety in pregnant women has not been established. Atorvastatin crosses the rat placenta and reaches a level in fetal liver equivalent to that of maternal plasma. Atorvastatin was not teratogenic in rats at doses up to 300 mg/kg/day or in rabbits at doses up to 100 mg/kg/day. These doses resulted in multiples of about 30 times (rat) or 20 times (rabbit) the human exposure based on surface area (mg/m^2). In a study in rats given 20, 100, or 225 mg/kg/day, from gestation day 7 through to lactation day 21 (weaning), there was decreased pup survival at birth, neonate, weaning, and maturity in pups of mothers dosed with 225 mg/kg/day. Body weight was decreased on days 4 and 21 in pups of mothers dosed at 100 mg/kg/day; pup body weight was decreased at birth and at days 4, 21, and 91 at 225 mg/kg/day. Pup development was delayed (rotorod performance at 100 mg/kg/day and acoustic startle at 225 mg/kg/day; pinnae detachment and eye opening at 225 mg/kg/day). These doses correspond to 6 times (100 mg/kg) and 22 times (225 mg/kg) the human AUC at 80 mg/day. Rare reports of congenital anomalies have been received following intrauterine exposure to HMG-CoA reductase inhibitors. There has been one report of severe congenital bony deformity, tracheo-esophageal fistula, and anal atresia (VATER association) in a baby born to a woman who took lovastatin with dextroamphetamine sulfate during the first trimester of pregnancy. LIPITOR should be administered to women of child-bearing potential only when such patients are highly unlikely to conceive and have been informed of the potential hazards. If the woman becomes pregnant while taking LIPITOR, it should be discontinued and the patient advised again as to the potential hazards to the fetus. **Nursing Mothers:** Nursing rat pups had plasma and liver drug levels of 50% and 40%, respectively, of that in their mother's milk. Because of the potential for adverse reactions in nursing infants, women taking LIPITOR should not breast-feed (see CONTRAINDICATIONS). **Pediatric Use:** Treatment experience in a pediatric population is limited to doses of LIPITOR up to 80 mg/day for 1 year in 8 patients with homozygous FH. No clinical or biochemical abnormalities were reported in these patients. None of these patients was below 9 years of age. **Geriatric Use:** Treatment experience in adults age ≥70 years with doses of LIPITOR up to 80 mg/day has been evaluated in 221 patients. The safety and efficacy of LIPITOR in this population were similar to those of patients <70 years of age.

ADVERSE REACTIONS: LIPITOR is generally well-tolerated. Adverse reactions have usually been mild and transient. In controlled clinical studies of 2502 patients, <2% of patients were discontinued due to adverse experiences attributable to atorvastatin. The most frequent adverse events thought to be related to atorvastatin were constipation, flatulence, dyspepsia, and abdominal pain. **Clinical Adverse Experiences:** Adverse experiences reported in ≥2% of patients in placebo-controlled clinical studies of atorvastatin, regardless of causality assessment, are shown in the following table.

Adverse Events in Placebo-Controlled Studies (% of Patients)

BODY SYSTEM Adverse Event	Placebo N = 270	Atorvastatin 10 mg N = 863	Atorvastatin 20 mg N = 36	Atorvastatin 40 mg N = 79	Atorvastatin 80 mg N = 94
BODY AS A WHOLE					
Infection	10.0	10.3	2.8	10.1	7.4
Headache	7.0	5.4	16.7	2.5	6.4
Accidental Injury	3.7	4.2	0.0	1.3	3.2
Flu Syndrome	1.9	2.2	0.0	2.5	3.2
Abdominal Pain	0.7	2.8	0.0	3.8	2.1
Back Pain	3.0	2.8	0.0	3.8	1.1
Allergic Reaction	2.6	0.9	2.8	1.3	0.0
Asthenia	1.9	2.2	0.0	3.8	0.0
DIGESTIVE SYSTEM					
Constipation	1.8	2.1	0.0	2.5	1.1
Diarrhea	1.5	2.7	0.0	3.8	5.3
Dyspepsia	4.1	2.3	2.8	1.3	2.1
Flatulence	3.3	2.1	2.8	1.3	1.1
RESPIRATORY SYSTEM					
Sinusitis	2.6	2.8	0.0	2.5	6.4
Pharyngitis	1.5	2.5	0.0	1.3	2.1
SKIN AND APPENDAGES					
Rash	0.7	3.9	2.8	3.8	1.1
MUSCULOSKELETAL SYSTEM					
Arthralgia	1.5	2.0	0.0	5.1	0.0
Myalgia	1.1	3.2	5.6	1.3	0.0

The following adverse events were reported, regardless of causality assessment in patients treated with atorvastatin in clinical trials. The events in italics occurred in ≥2% of patients and the events in plain type occurred in <2% of patients.

Body as a Whole: *Chest pain*, face edema, fever, neck rigidity, malaise, photosensitivity reaction, generalized edema. ***Digestive System:*** *Nausea*, gastroenteritis, liver function tests abnormal, colitis, vomiting, gastritis, dry mouth, rectal hemorrhage, esophagitis, eructation, glossitis, mouth ulceration, anorexia, increased appetite, stomatitis, biliary pain, cheilitis, duodenal ulcer, dysphagia, enteritis, melena, gum hemorrhage, stomach ulcer, tenesmus, ulcerative stomatitis, hepatitis, pancreatitis, cholestatic jaundice. ***Respiratory System:*** *Bronchitis, rhinitis*, pneumonia, dyspnea, asthma, epistaxis. ***Nervous System:*** *Insomnia, dizziness*, paresthesia, somnolence, amnesia, abnormal dreams, libido decreased, emotional lability, incoordination, peripheral neuropathy, torticollis, facial paralysis, hyperkinesia, depression, hypesthesia, hypertonia. ***Musculoskeletal System:*** *Arthritis*, leg cramps, bursitis, tenosynovitis, myasthenia, tendinous contracture, myositis. ***Skin and Appendages:*** Pruritus, contact dermatitis, alopecia, dry skin, sweating, acne, urticaria, eczema, seborrhea, skin ulcer. ***Urogenital System:*** *Urinary tract infection*, urinary frequency, cystitis, hematuria, impotence, dysuria, kidney calculus, nocturia, epididymitis, fibrocystic breast, vaginal hemorrhage, albuminuria, breast enlargement, metrorrhagia, nephritis, urinary incontinence, urinary retention, urinary urgency, abnormal ejaculation, uterine hemorrhage. ***Special Senses:*** Amblyopia, tinnitus, dry eyes, refraction disorder, eye hemorrhage, deafness, glaucoma, parosmia, taste loss, taste perversion. ***Cardiovascular System:*** Palpitation, vasodilatation, syncope, migraine, postural hypotension, phlebitis, arrhythmia, angina pectoris, hypertension. ***Metabolic and Nutritional Disorders:*** *Peripheral edema*, hyperglycemia, creatine phosphokinase increased, gout, weight gain, hypoglycemia. ***Hemic and Lymphatic System:*** Ecchymosis, anemia, lymphadenopathy, thrombocytopenia, petechia. ***Postintroduction Reports:*** Adverse events associated with LIPITOR therapy reported since market introduction, that are not listed above, regardless of causality assessment, include the following: anaphylaxis, angioneurotic edema, bullous rashes (including erythema multiforme, Stevens-Johnson syndrome and toxic epidermal necrolysis), and rhabdomyolysis.

OVERDOSAGE: There is no specific treatment for atorvastatin overdosage. In the event of an overdose, the patient should be treated symptomatically, and supportive measures instituted as required. Due to extensive drug binding to plasma proteins, hemodialysis is not expected to significantly enhance atorvastatin clearance.

Consult package insert before prescribing LIPITOR® (Atorvastatin Calcium) Tablets.

℞ only

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An Artistic Pilgrimage to Jerusalem

The dense mosaic of Jerusalem's Old City crowds the grounds of the Dome of the Rock, one of Islam's holiest sites, in this remarkable depiction by Belgian artist Norbert Ceulemans.

Inheritor of a centuries-old Flemish tradition, Ceulemans has produced axonometric maps of some 30 cities. These maps combine cartographic accuracy with three-dimensional views of buildings and other landmarks.

After studying maps, making hundreds of aerial photographs, and walking the streets with a camera in hand, Ceulemans spends countless hours at a drafting table drawing and coloring each building in loving detail.

"This is the crown jewel of my work," Ceulemans says. "None of my earlier projects has so moved me."

You can peruse the Jerusalem map and Ceulemans's most recent creation, a view of central London, at *www.nationalgeographic.com/maps.*

TEXT BY ALLEN CARROLL
Chief Cartographer

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"Just staggering," says Stephen Alvarez about the Chiquibul cave system. His photographs illustrate the article in this issue, but he also captured 360° views of its underground wonders. Alvarez shot with a fish-eye lens, then pivoted his camera 180° and shot again. Later a computer stitched the photos into a single spherical image that lets website visitors explore a cave as if they were inside. Experience Chiquibul at *www.nationalgeographic.com/chiquibul.*
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And to my dear Uncle Sam, I leave as little as possible.

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the Land Cruiser is a far more civilized way

to travel throughout an uncivilized world.

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